US007628265B2

(12) **United States Patent**
Verploegen et al.

(10) **Patent No.: US 7,628,265 B2**
(45) **Date of Patent: Dec. 8, 2009**

(54) **POSITIVE DISPLACEMENT SORTER SHOE**

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(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

(21) Appl. No.: **11/782,375**

(22) Filed: **Jul. 24, 2007**

(65) **Prior Publication Data**

US 2008/0011582 A1 Jan. 17, 2008

Related U.S. Application Data

(63) Continuation of application No. 10/903,707, filed on Jul. 30, 2004, now Pat. No. 7,249,668.

(60) Provisional application No. 60/492,144, filed on Aug. 1, 2003.

(51) **Int. Cl.**
B65G 47/00 (2006.01)

(52) **U.S. Cl.** **198/370.02**; 198/370.01; 198/456; 198/457.01; 198/458; 198/890; 198/890.1

(58) **Field of Classification Search** 198/370.02, 198/370.01, 456, 457.01, 458, 890, 890.1
See application file for complete search history.

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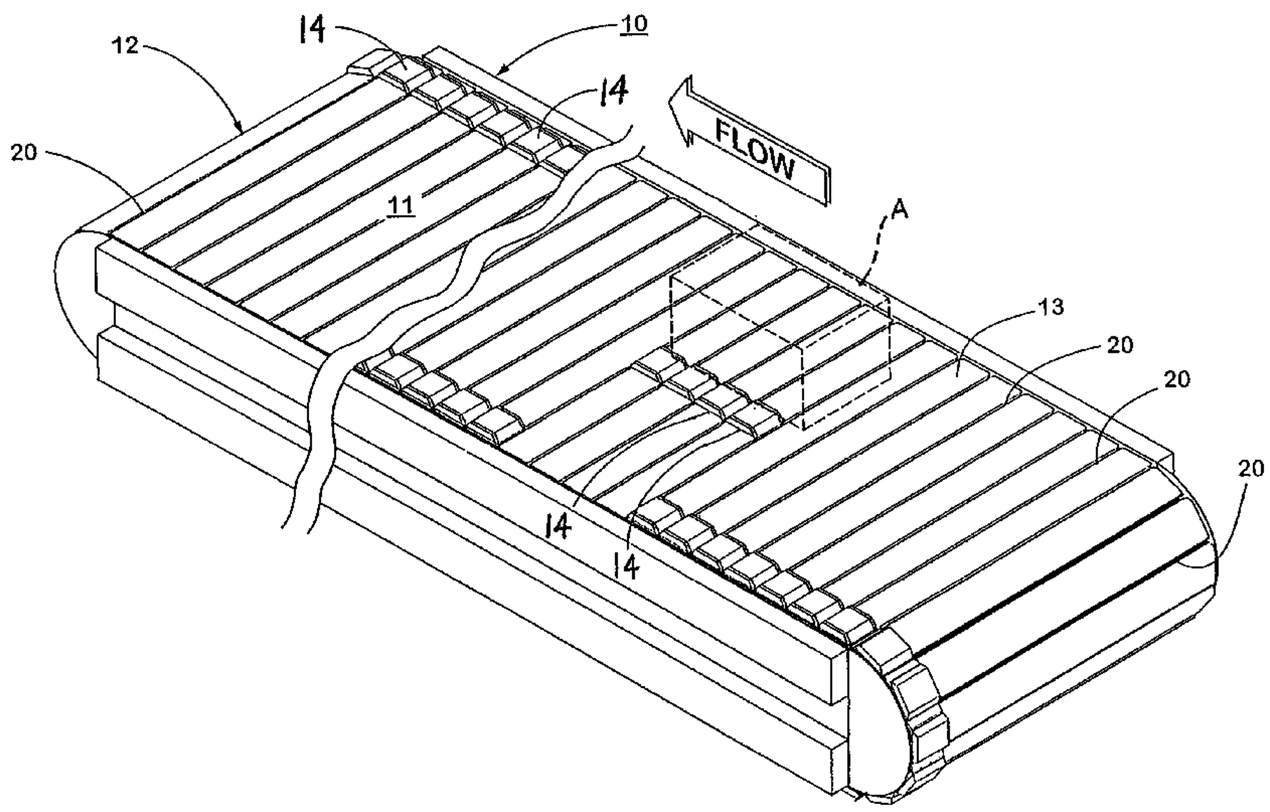
(57) **ABSTRACT**

A positive displacement sorter apparatus and method includes providing a plurality of interconnected slats defining an endless web, an upper run of the web defining a conveying surface. A plurality of pusher shoes are provided, each moving along at least one of the plurality of slats to laterally displace articles on the conveying surface. Each of the pusher shoes includes a diverting portion extending above the conveying surface. The diverting portion includes a diverting surface and a stop surface. The diverting surface contacts an article and laterally displaces that article. A lifting force is applied by the diverting surface to a portion of the article being diverted. The stop surface limits movement of the article relative to the pusher shoe.

10 Claims, 23 Drawing Sheets



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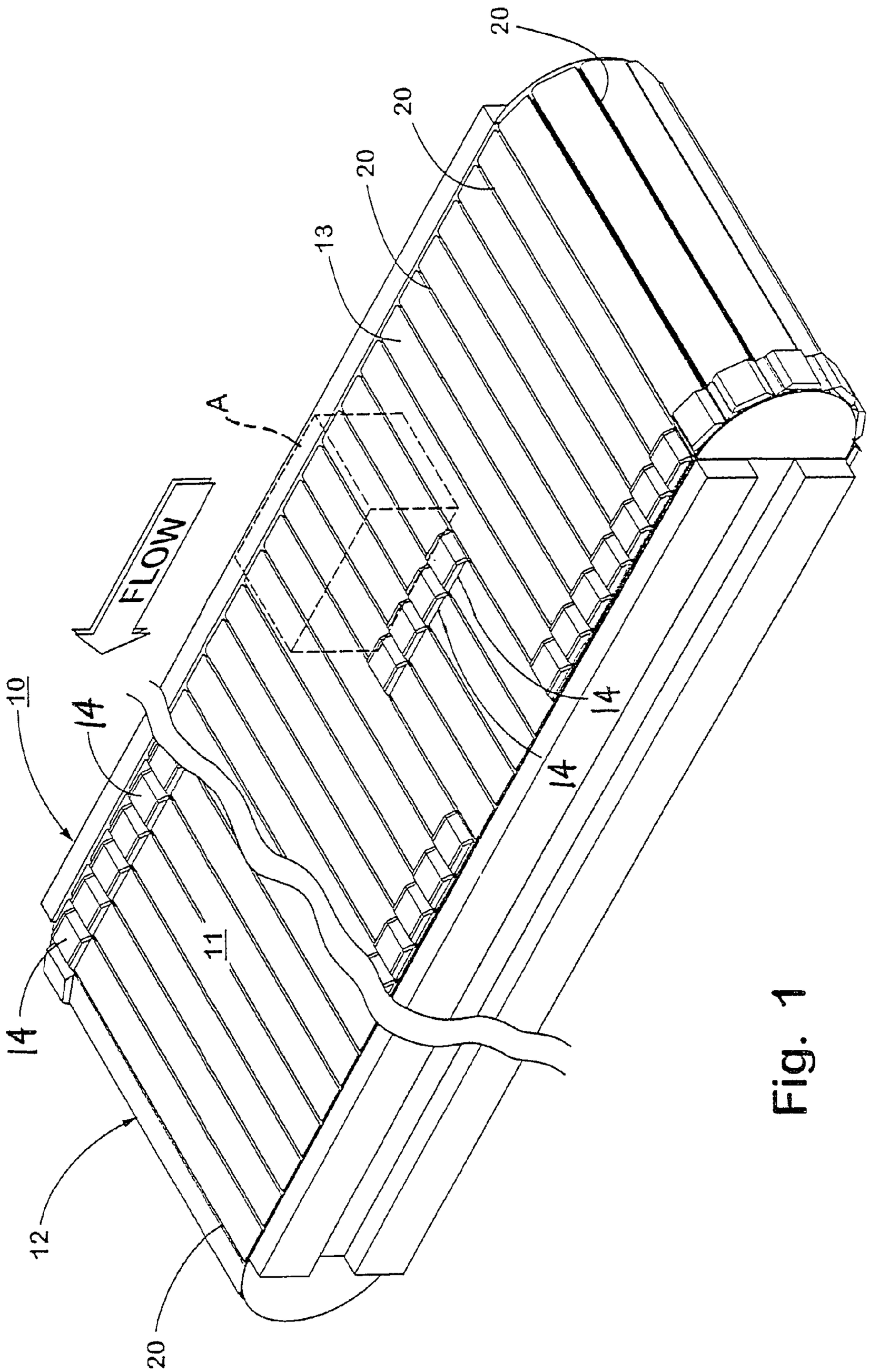

Fig. 1

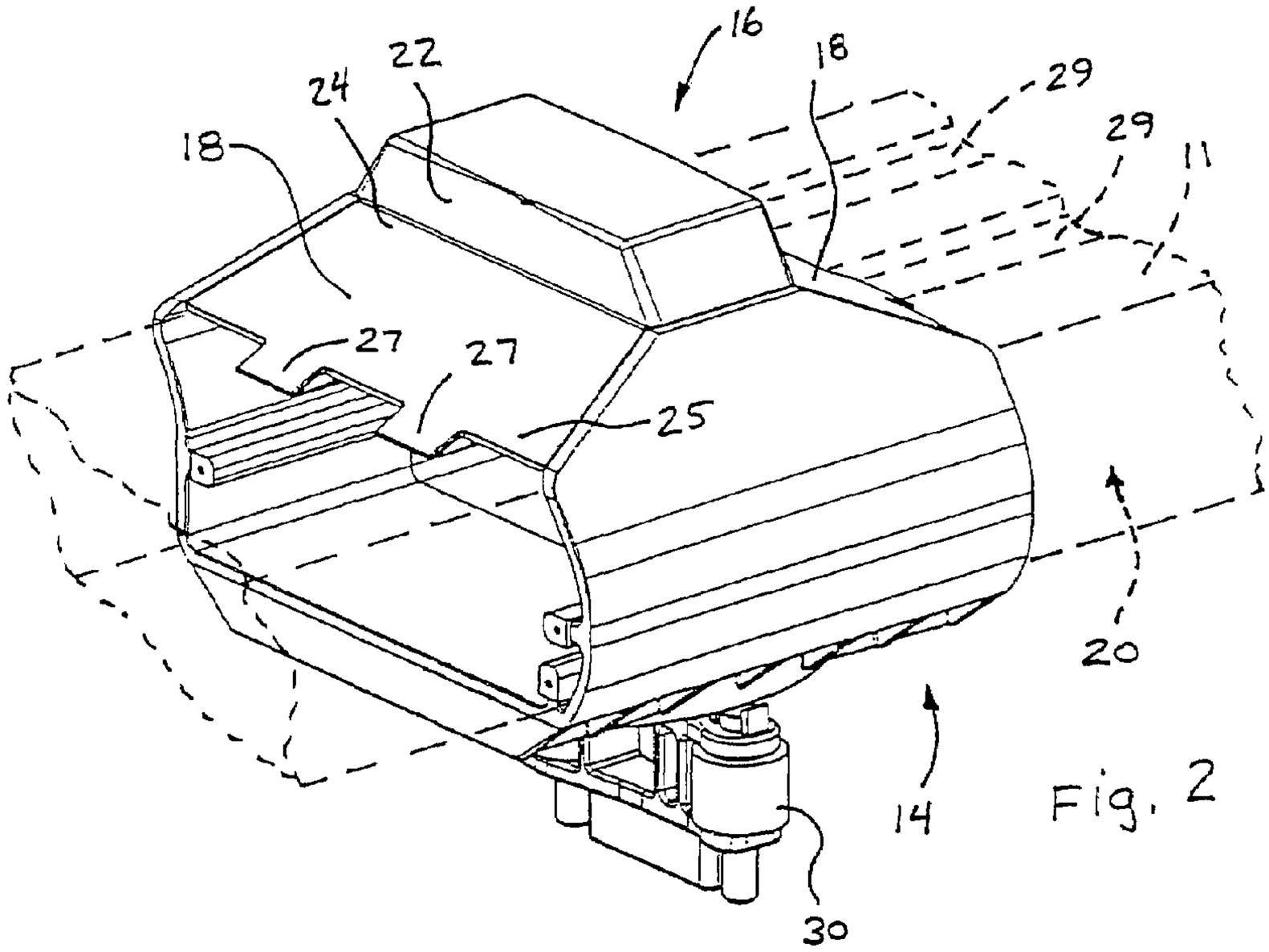

Fig. 2

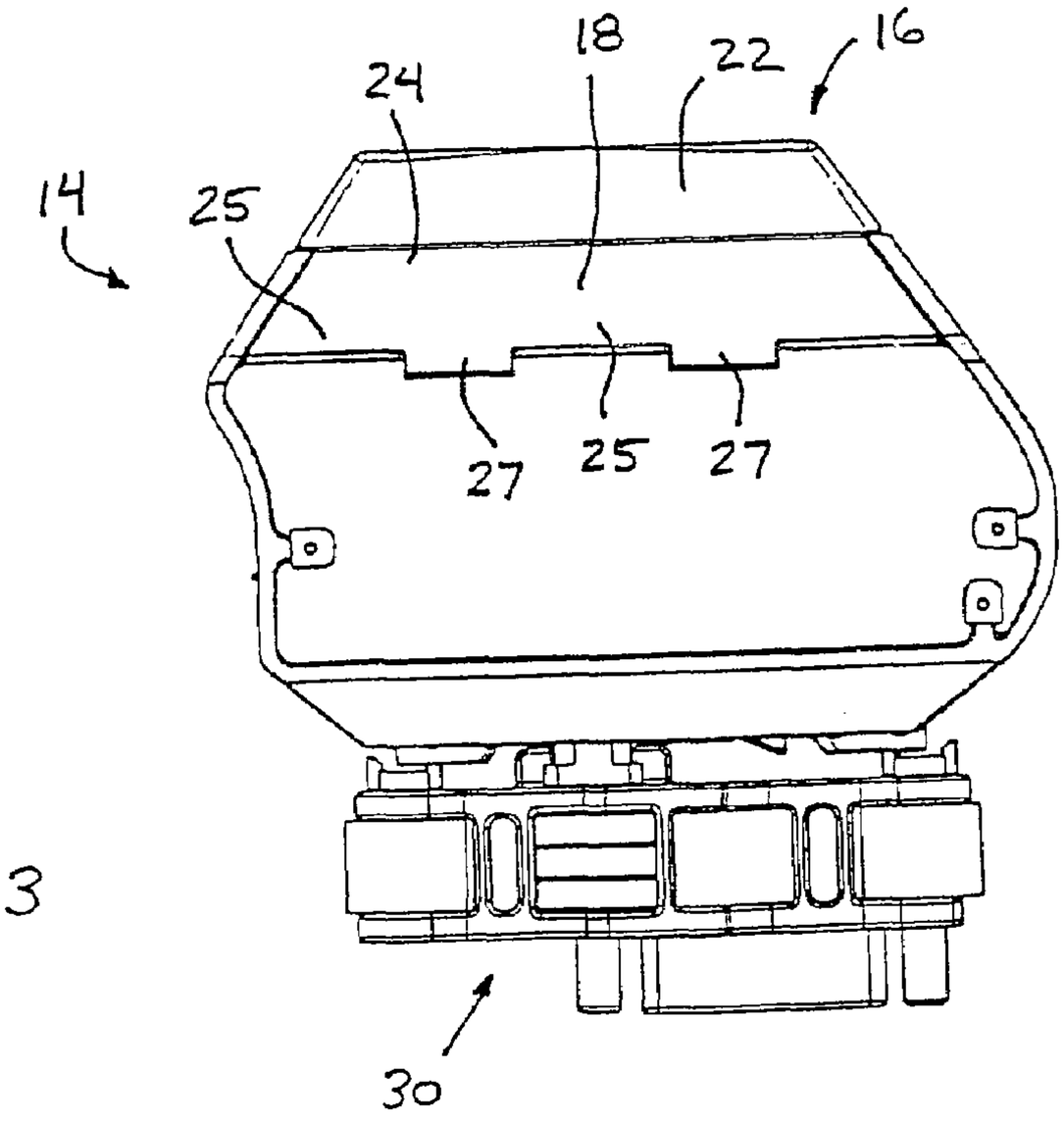

Fig. 3

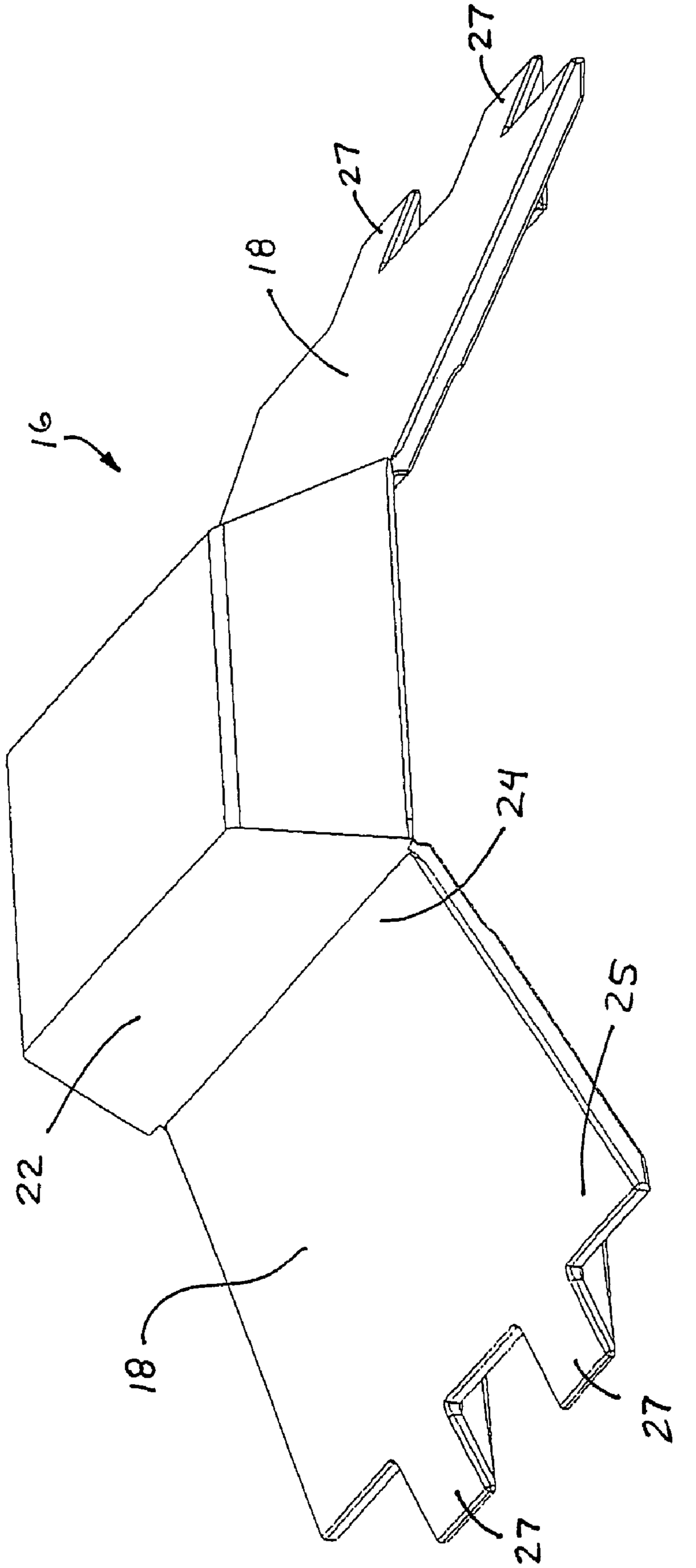

Fig. 4

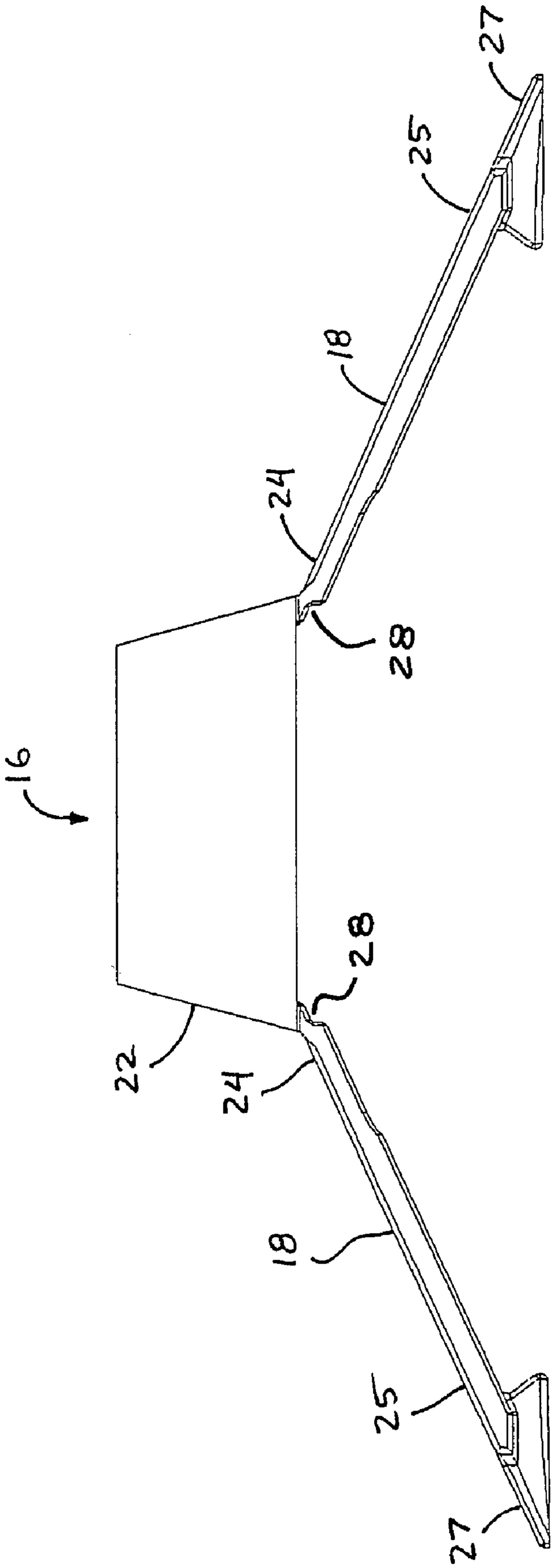

Fig. 5

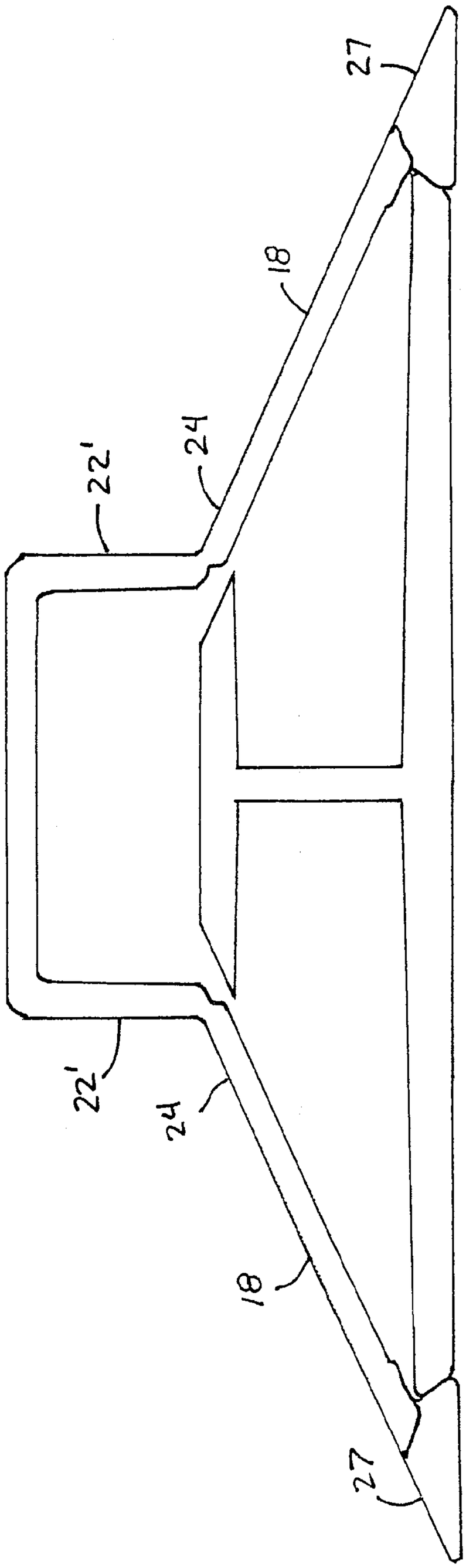

Fig. 6

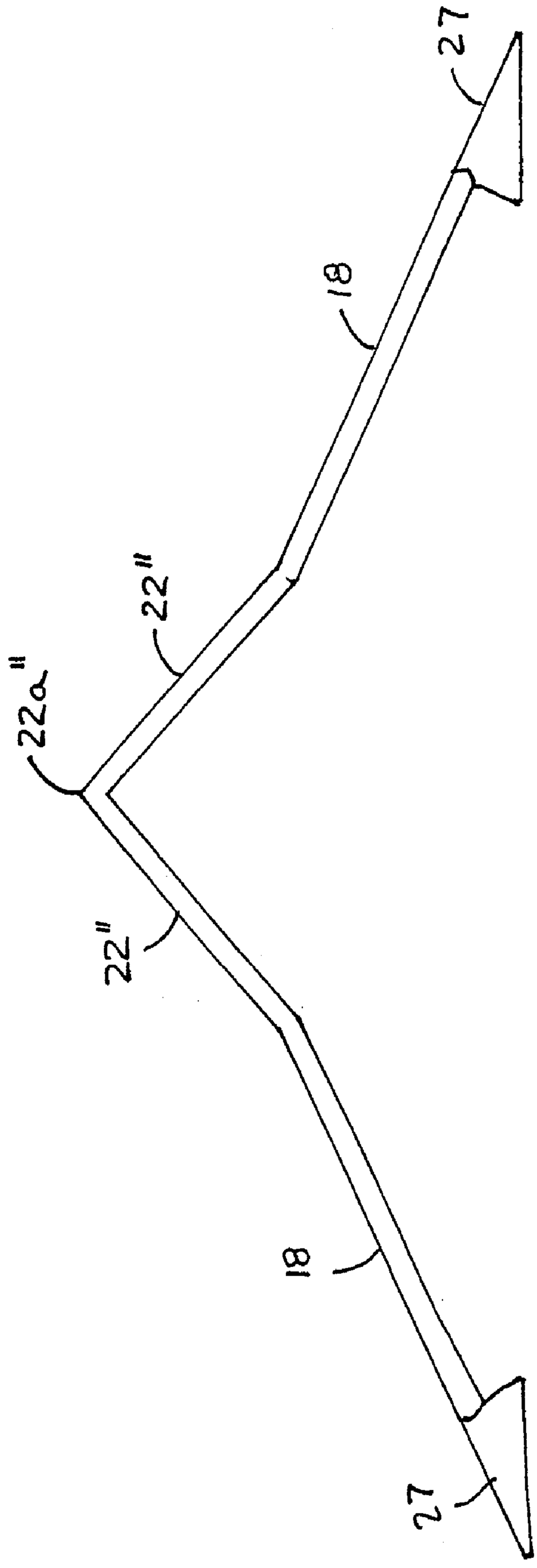

Fig. 7

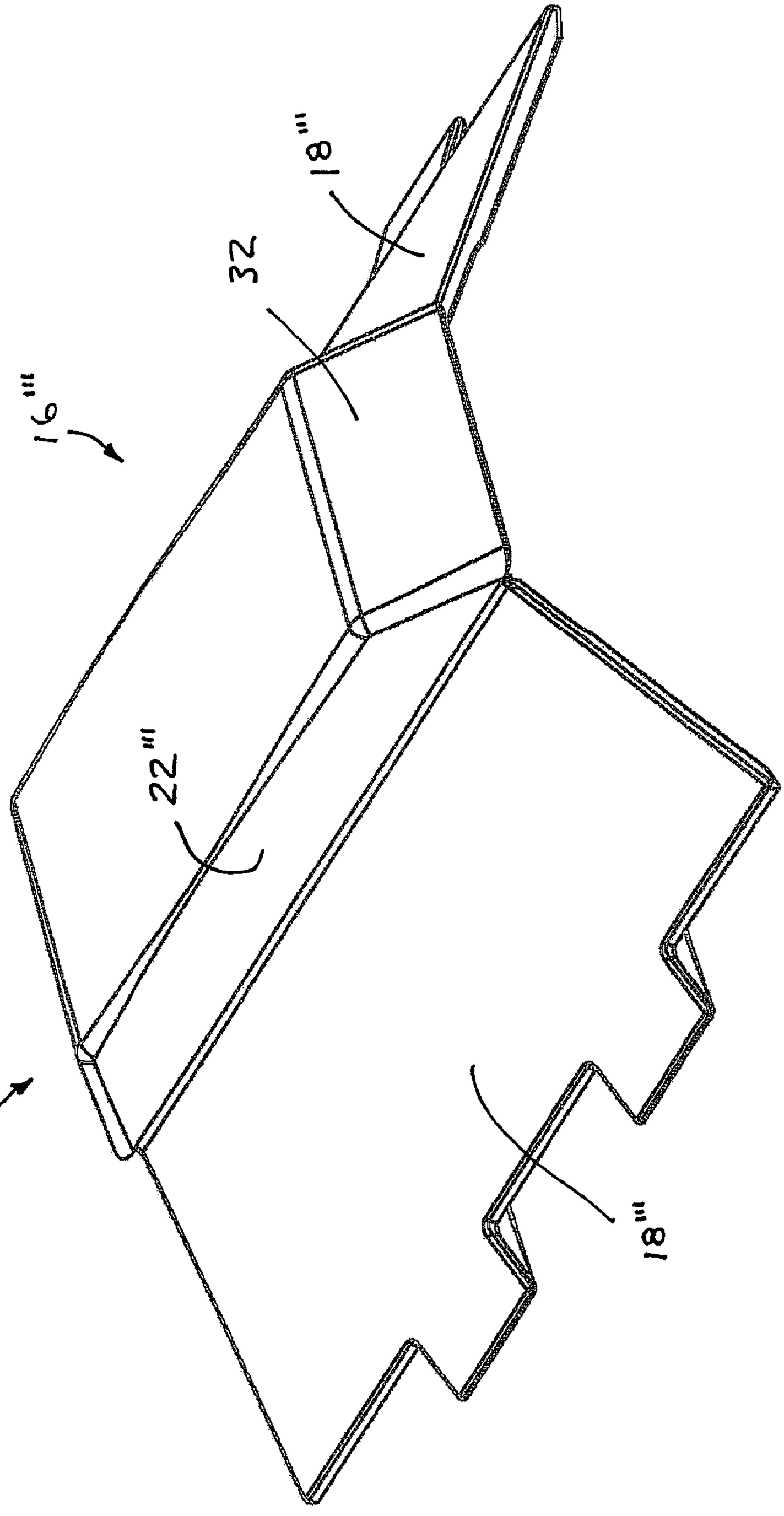

Fig. 8A

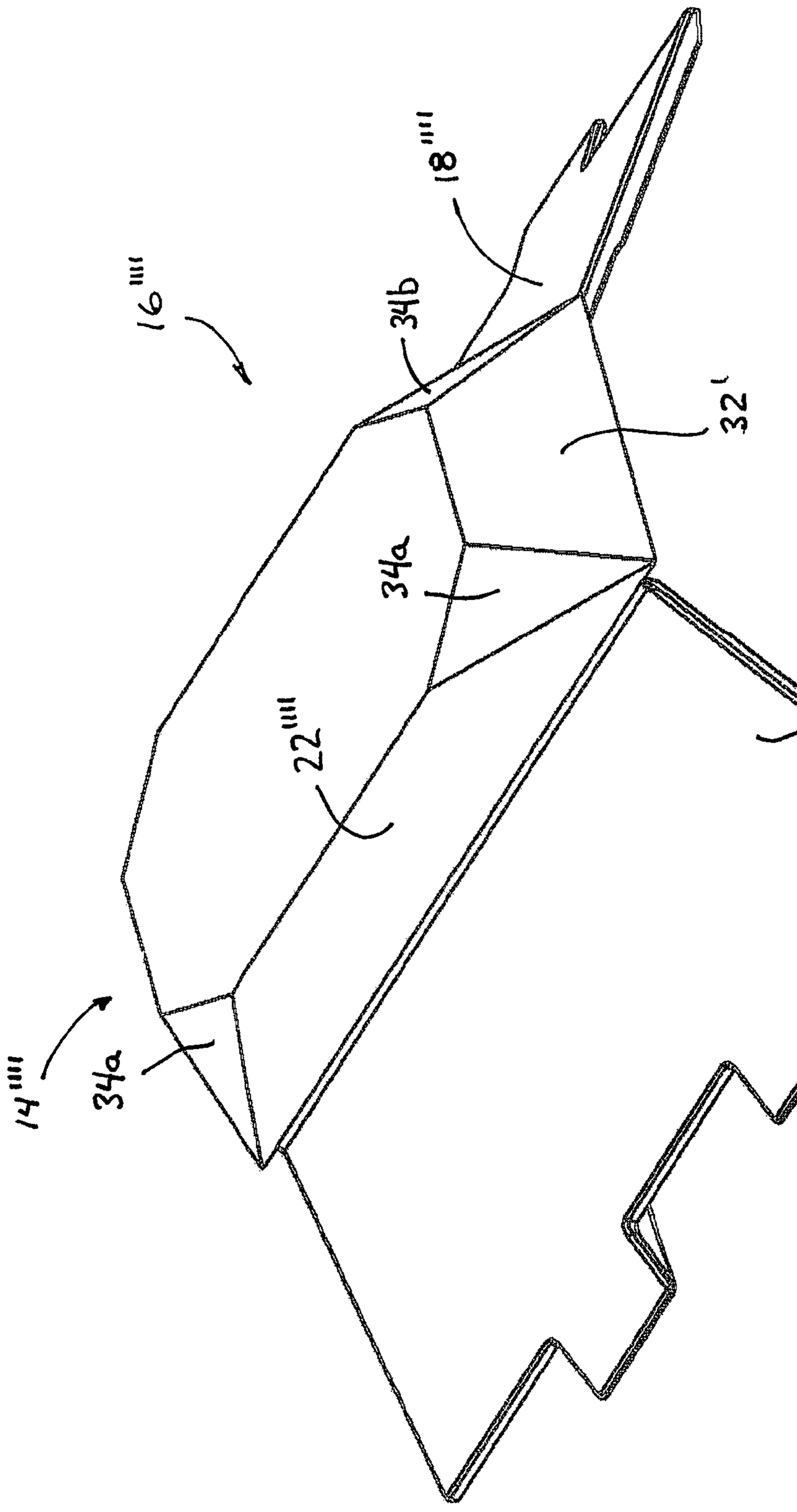

Fig. 8B

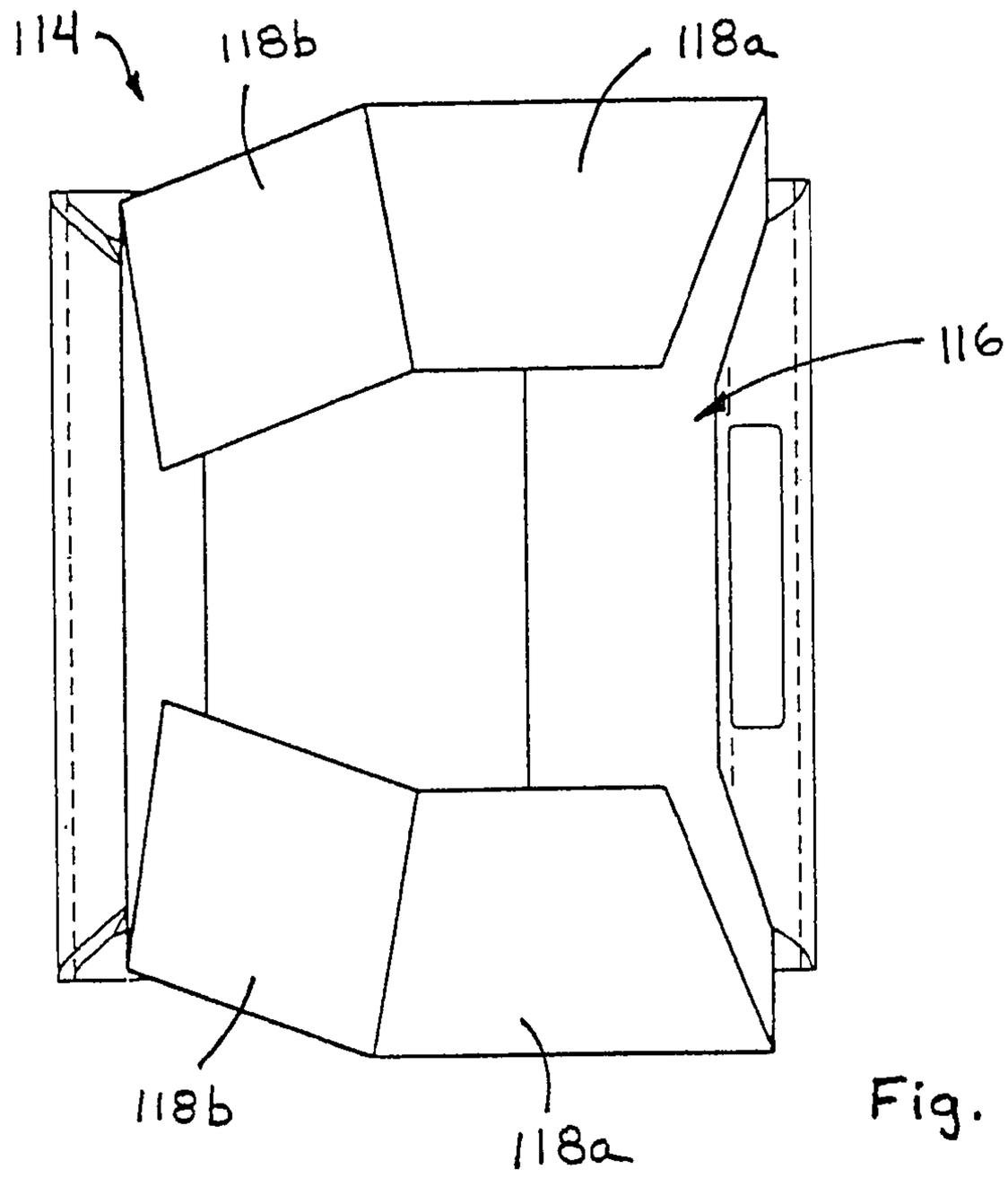

Fig. 9A

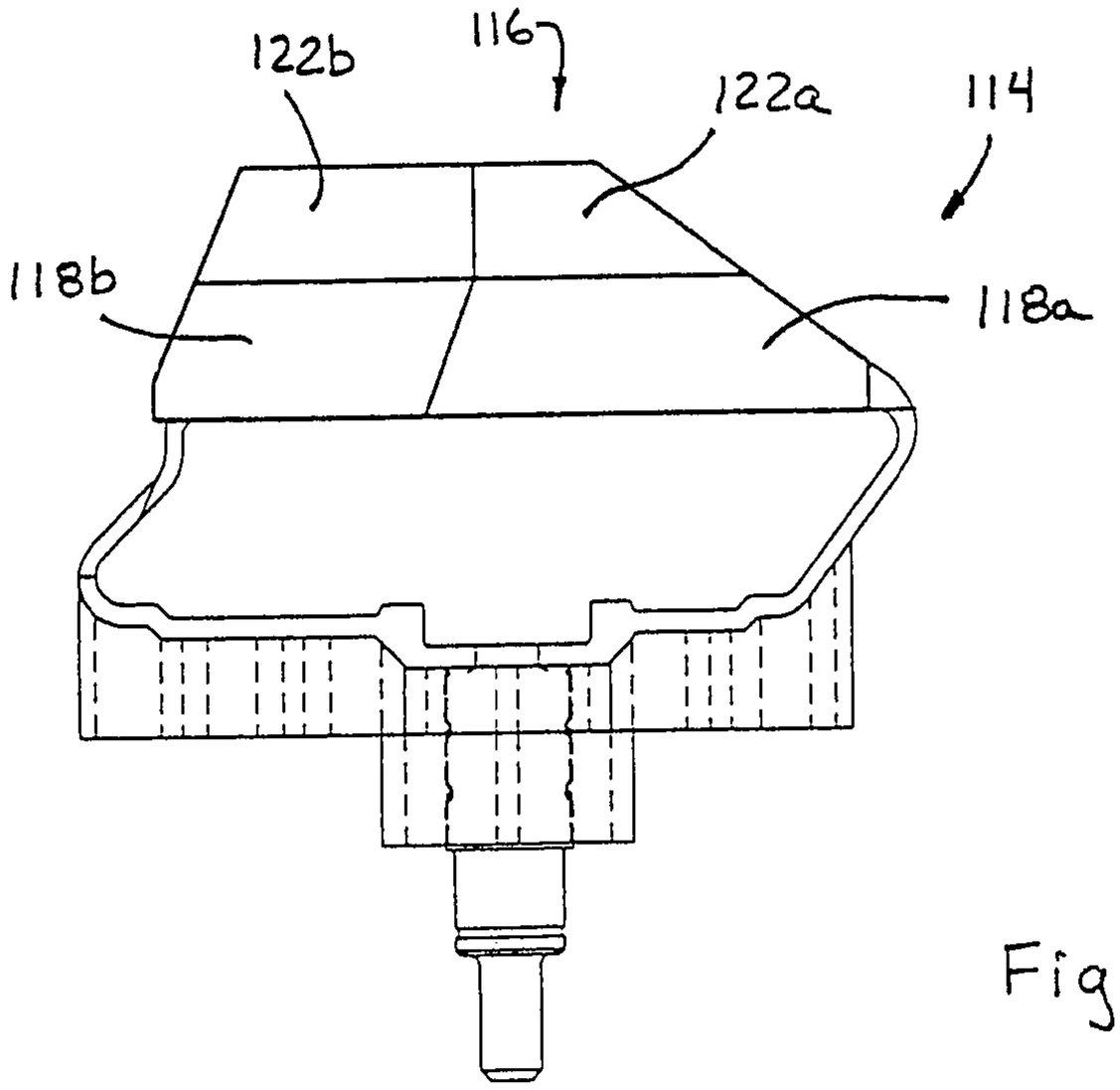

Fig. 9B

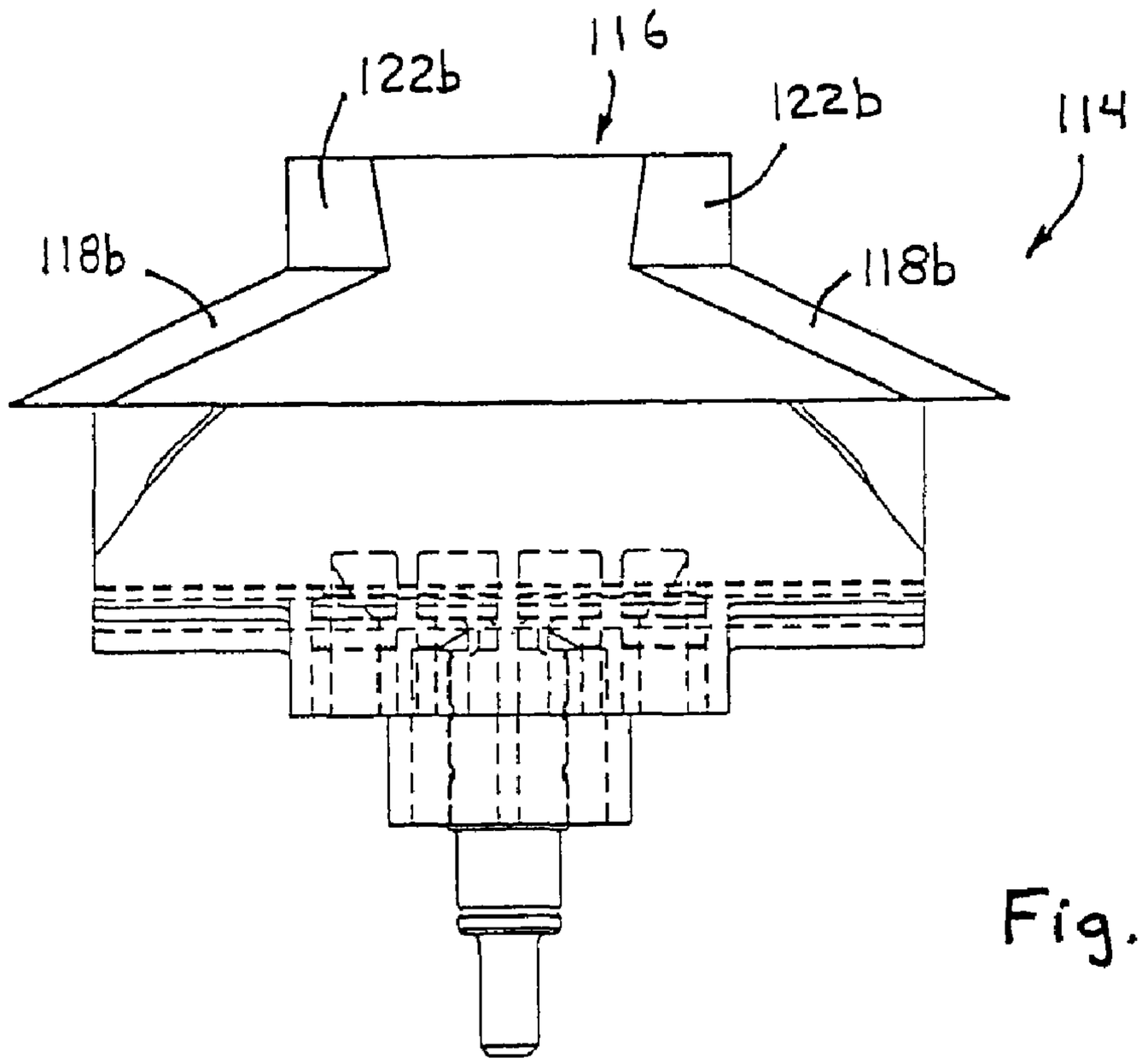

Fig. 9C

Fig. 9D

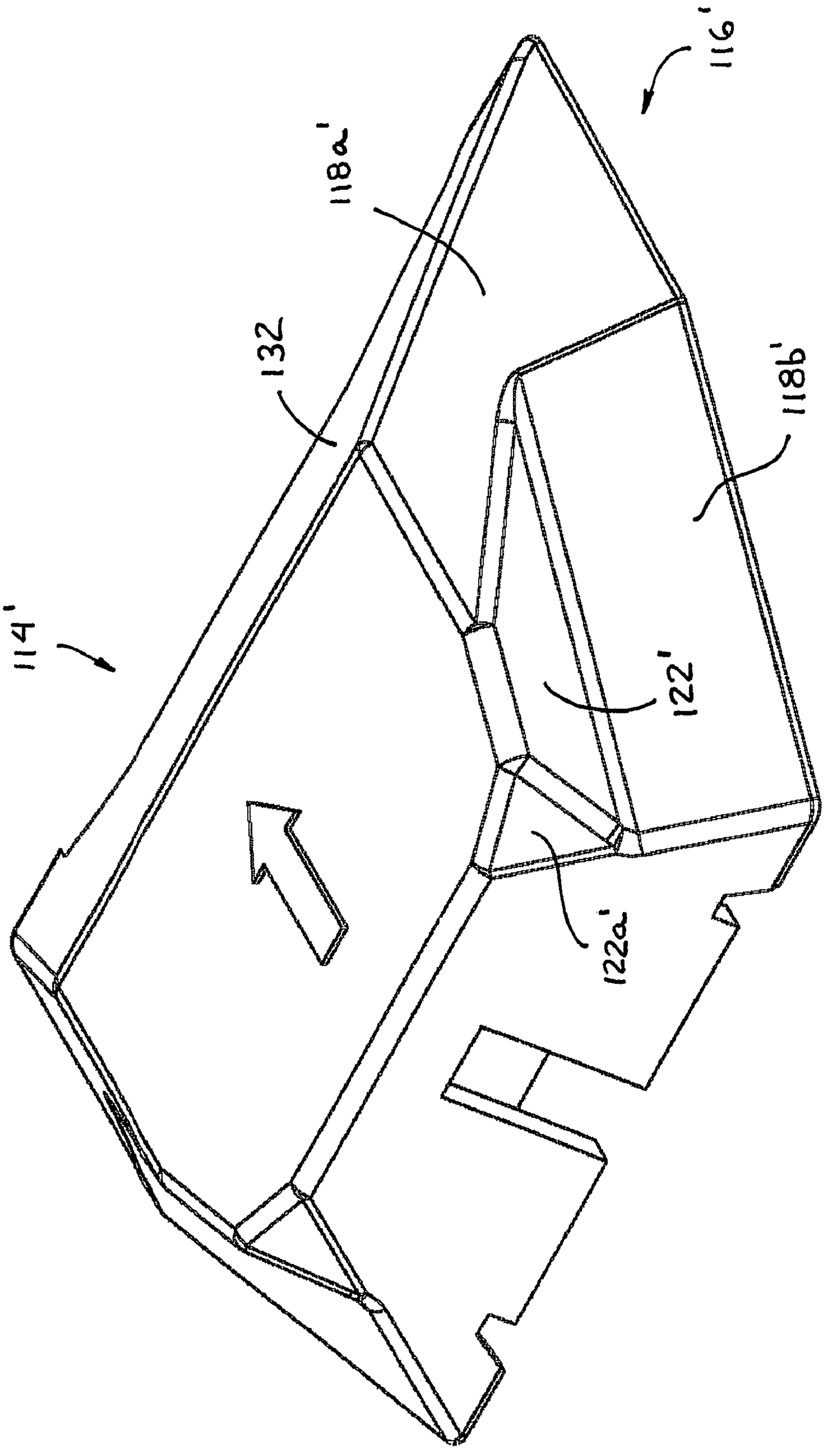

Fig. 10

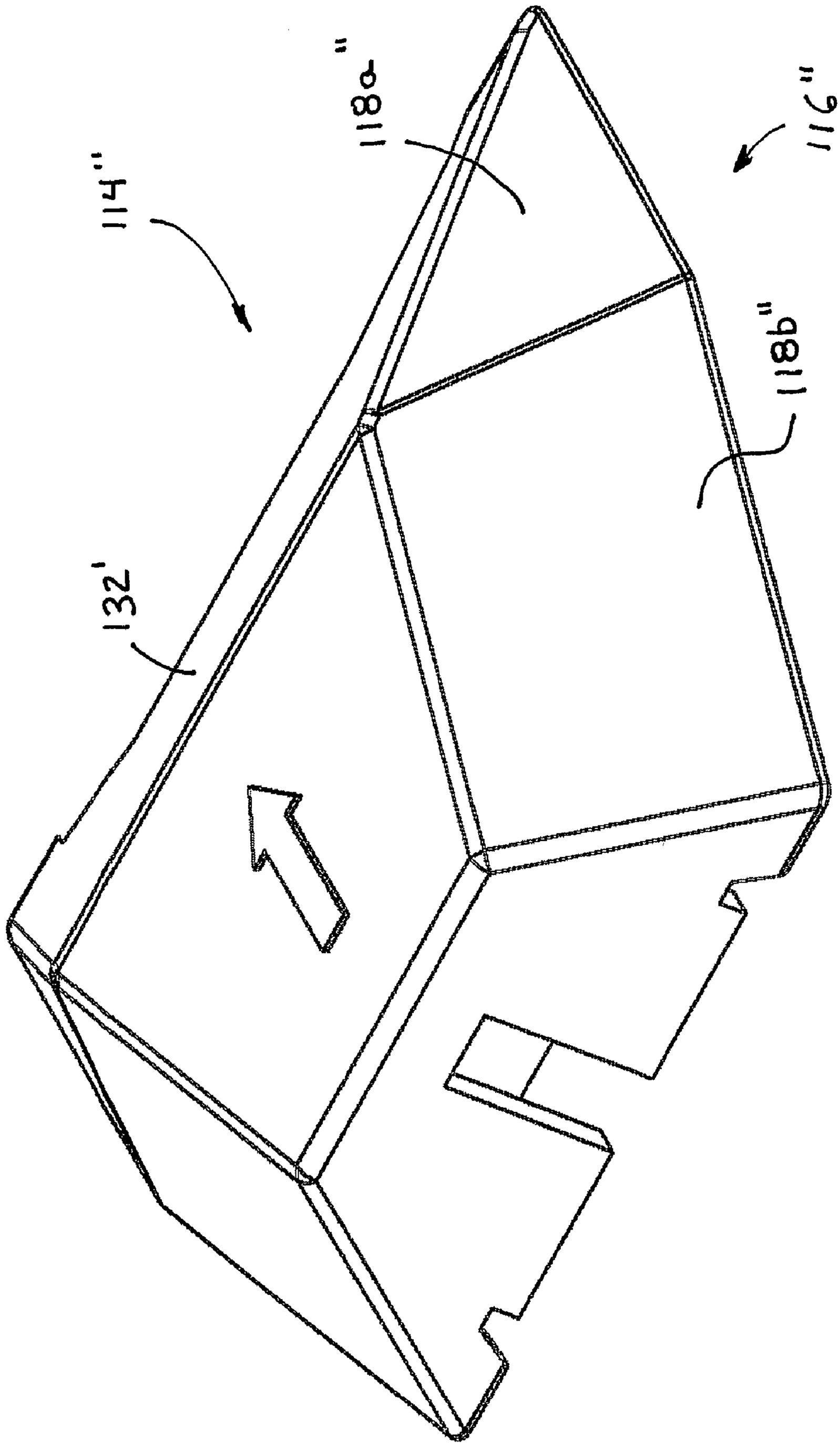

Fig. 11

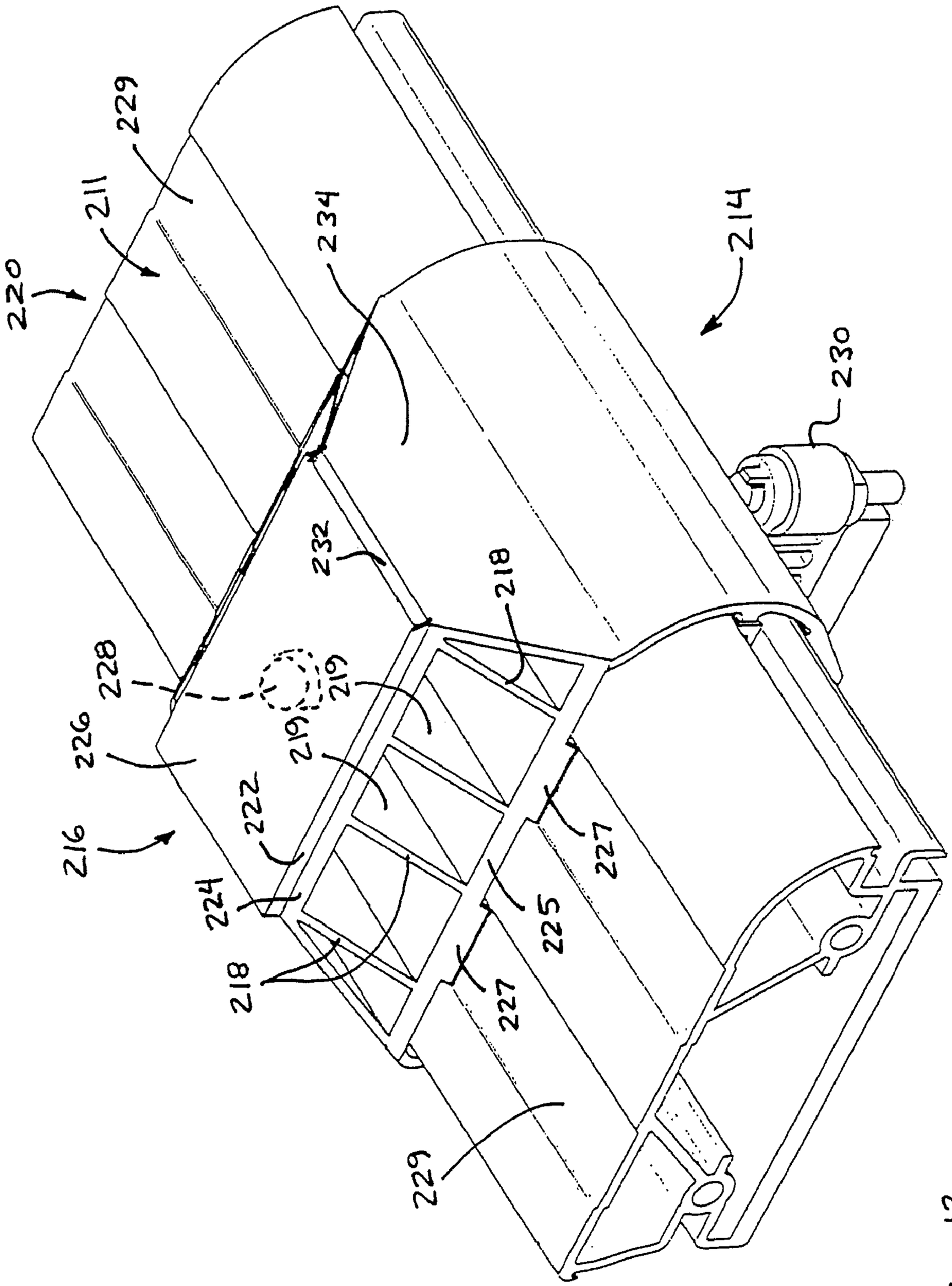
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Fig. 12

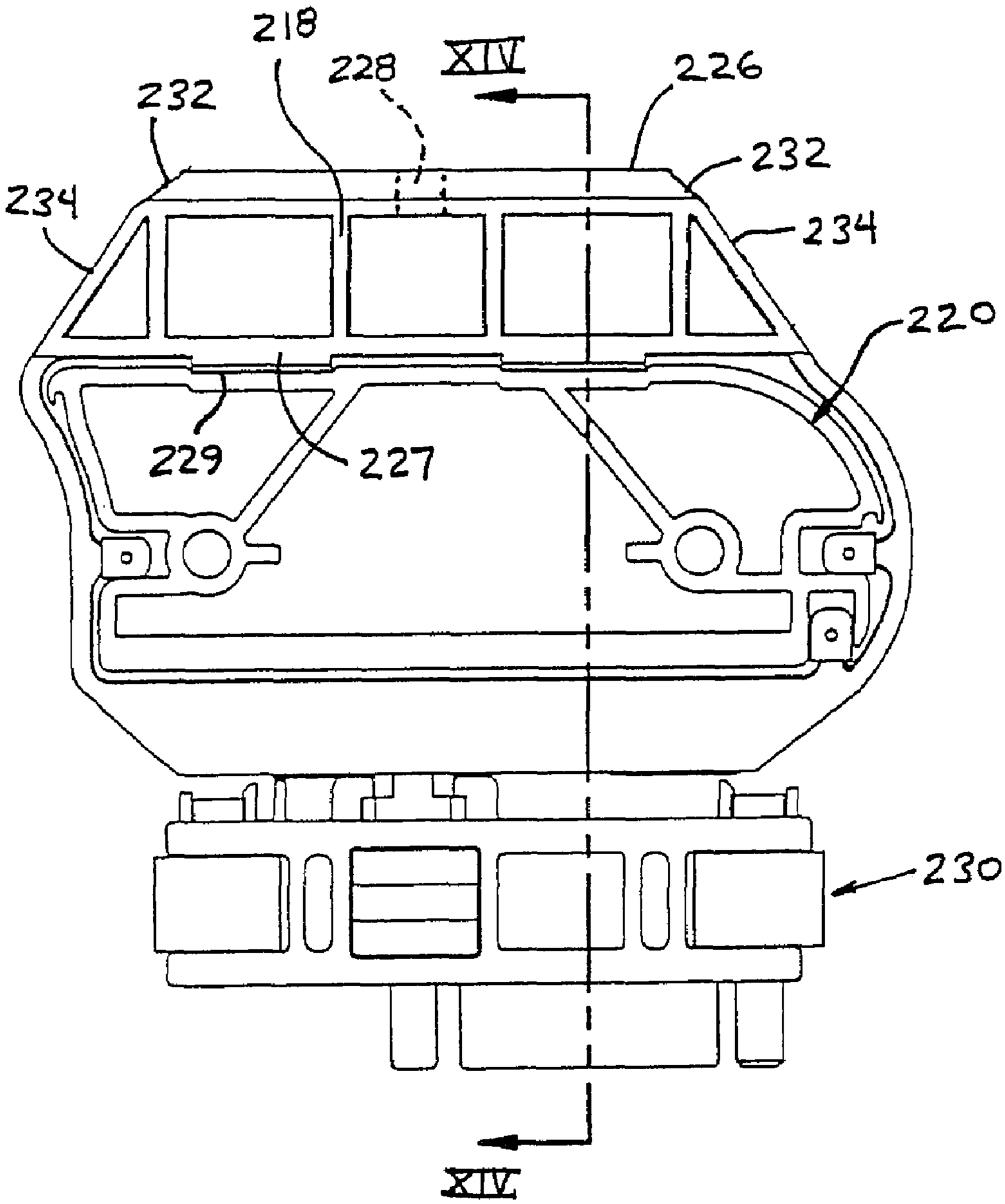

Fig. 13

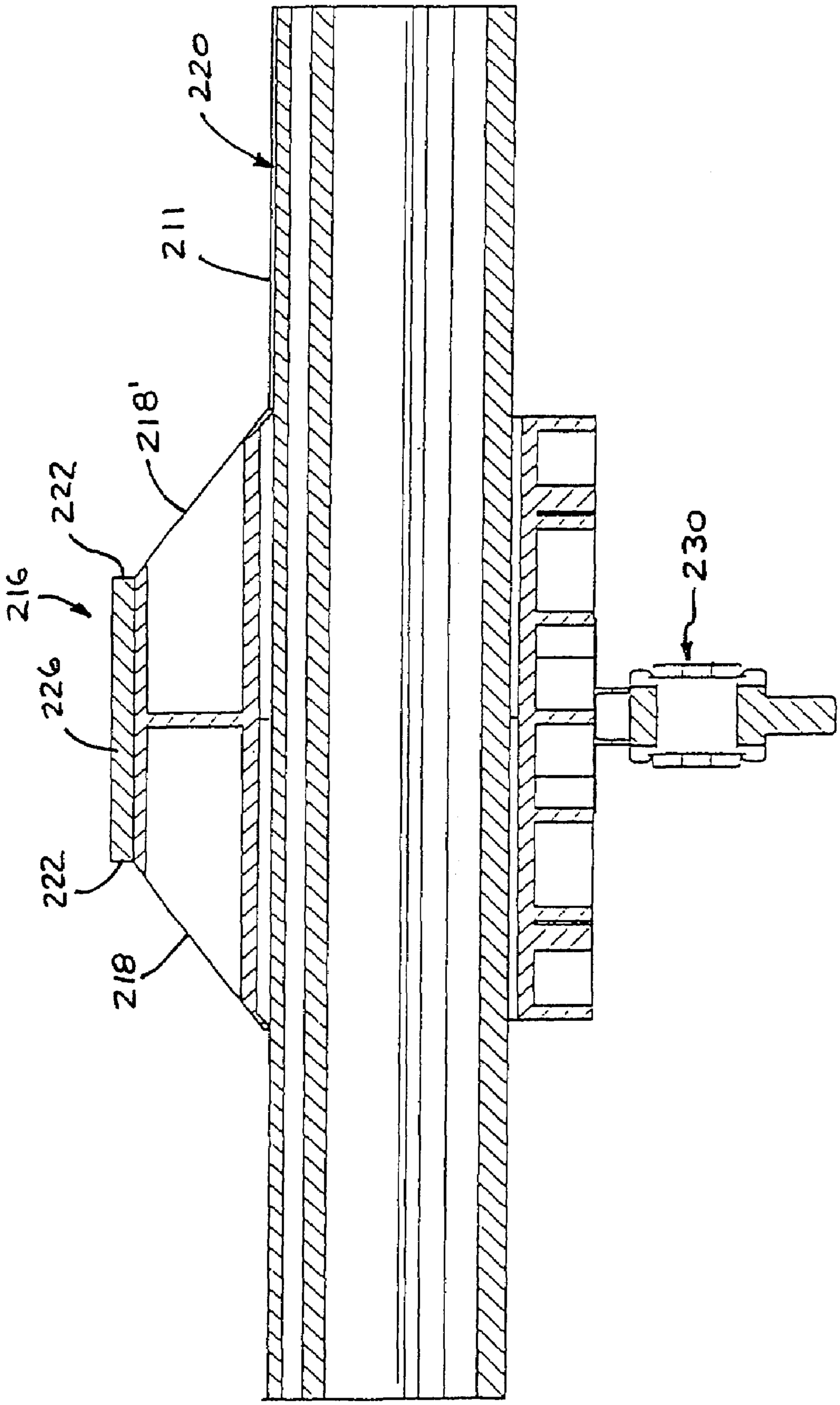

Fig. 14

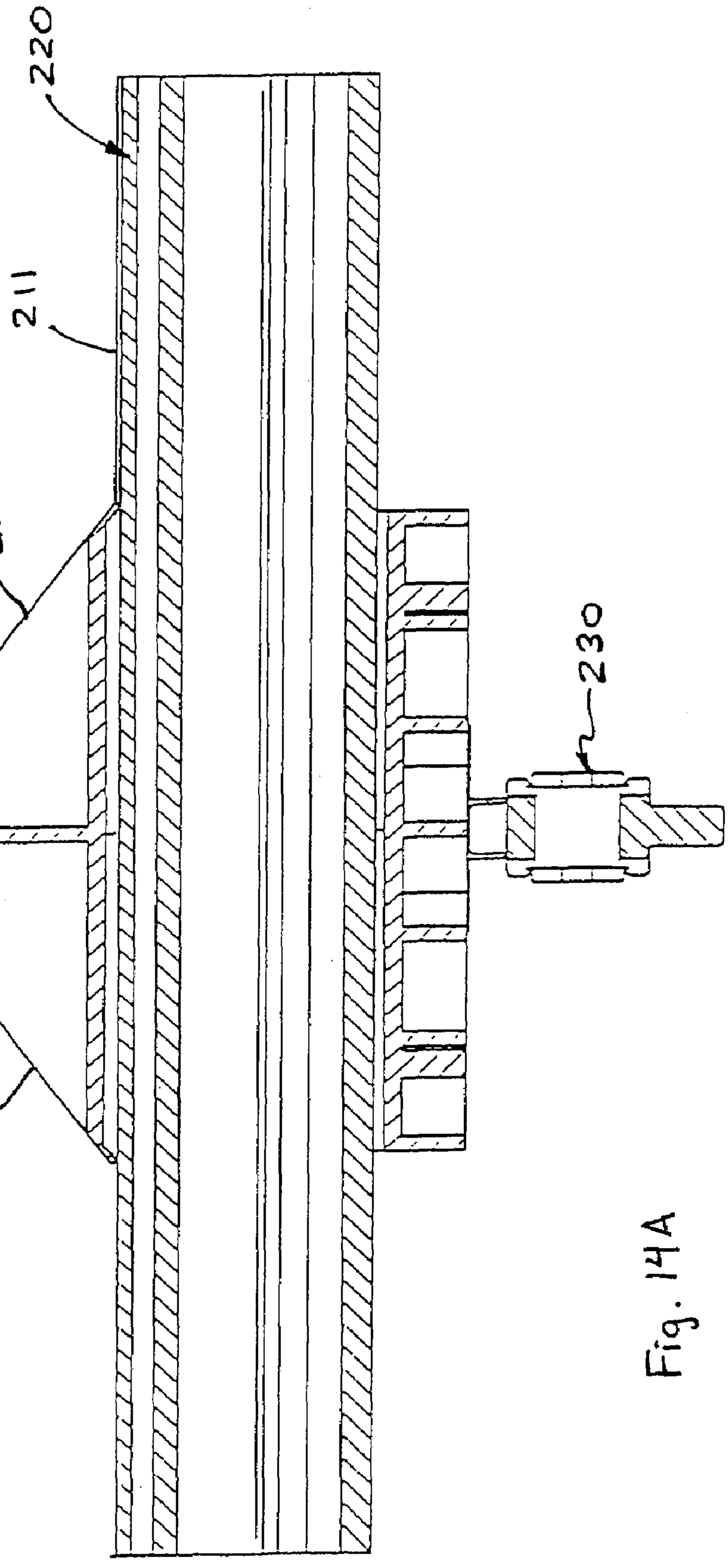

Fig. 14A

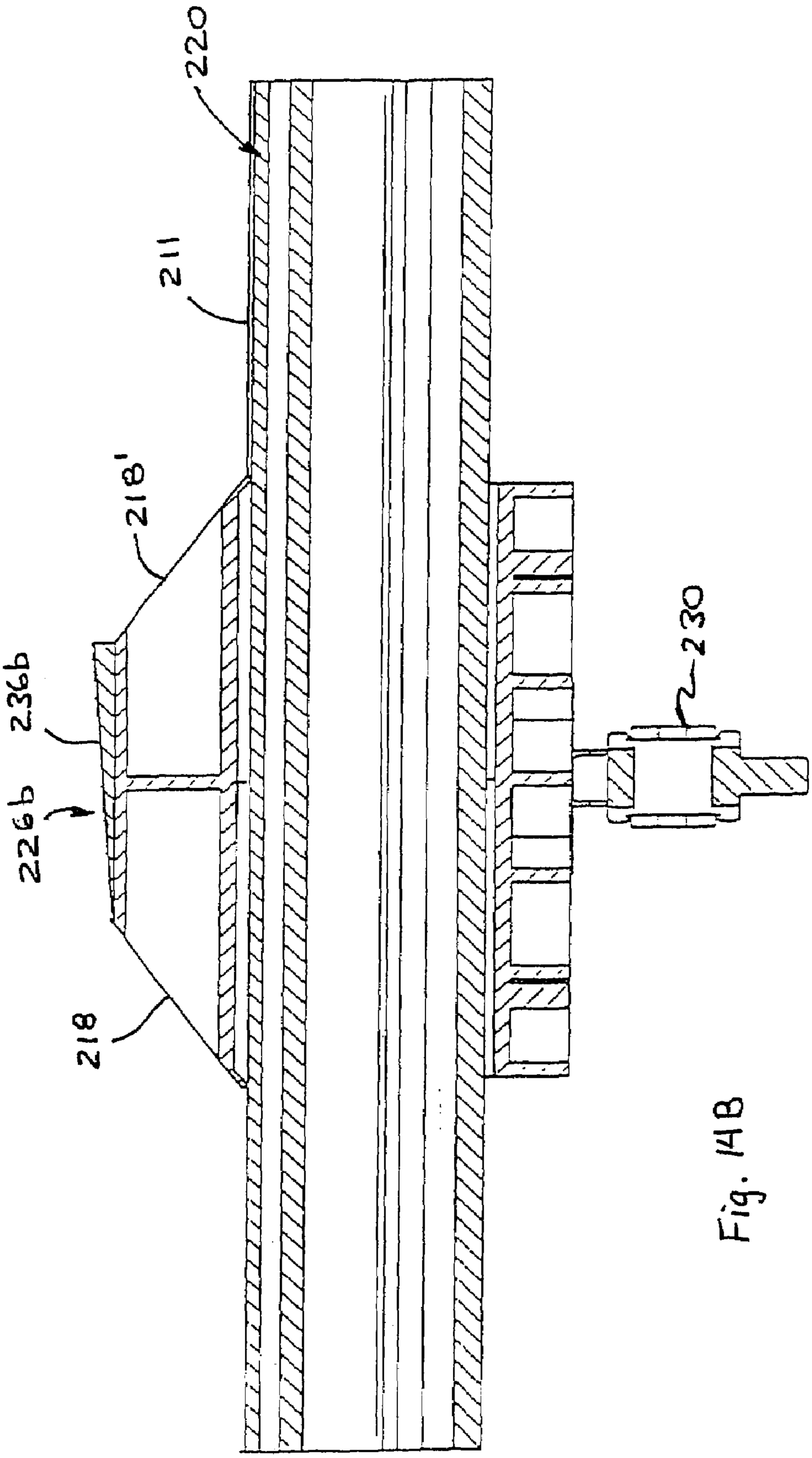

Fig. 14B

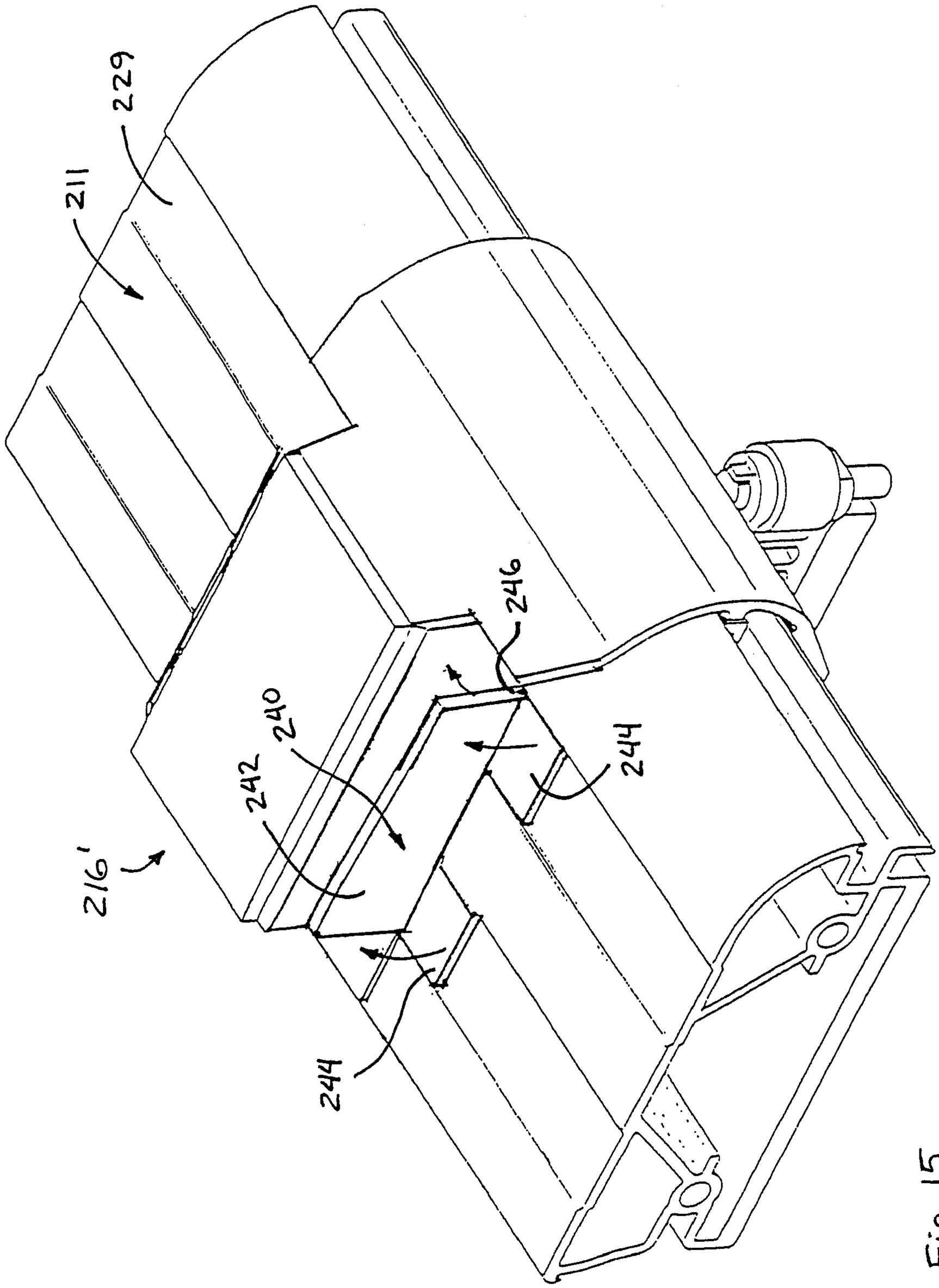

Fig. 15

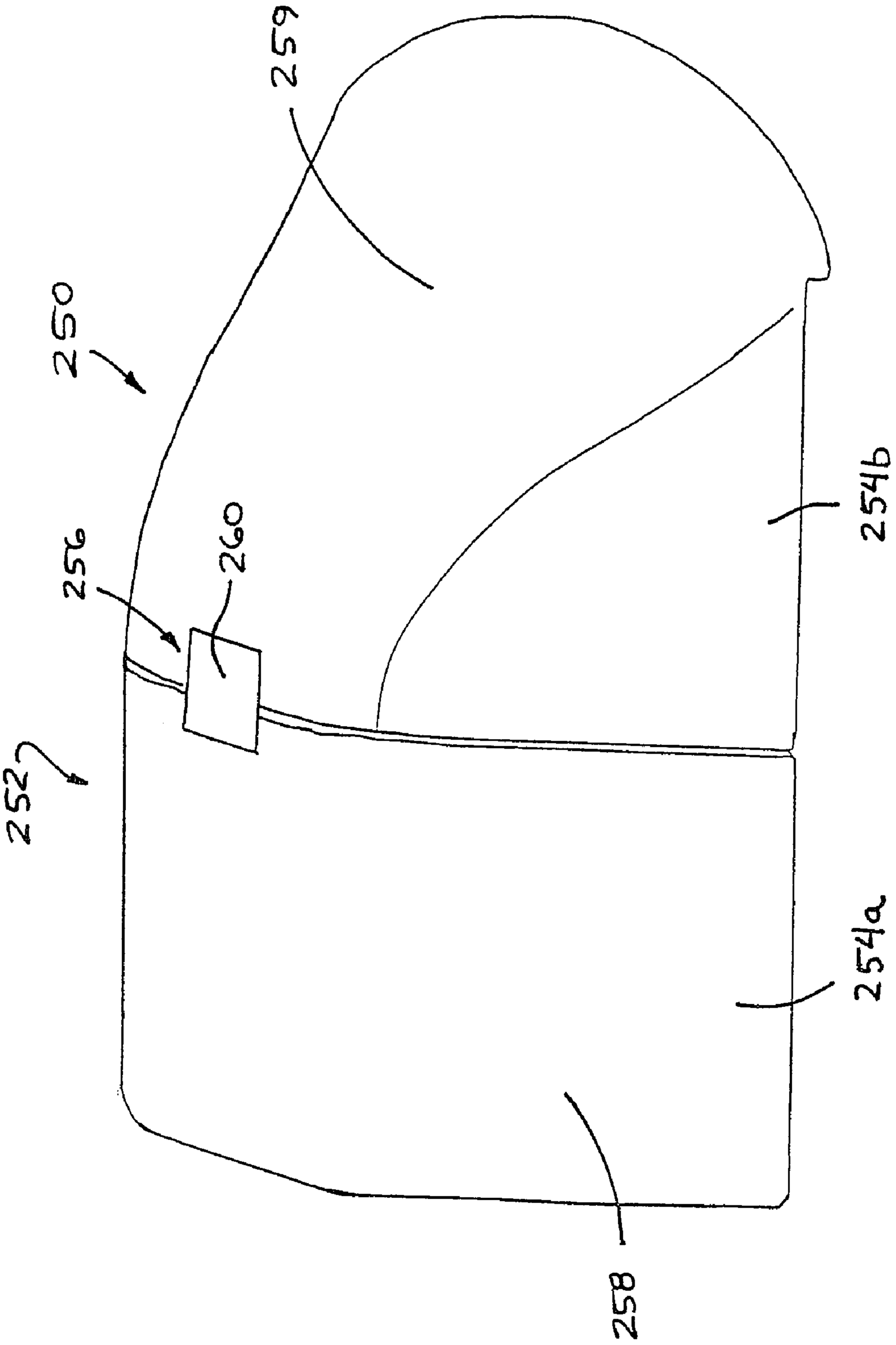

Fig. 16

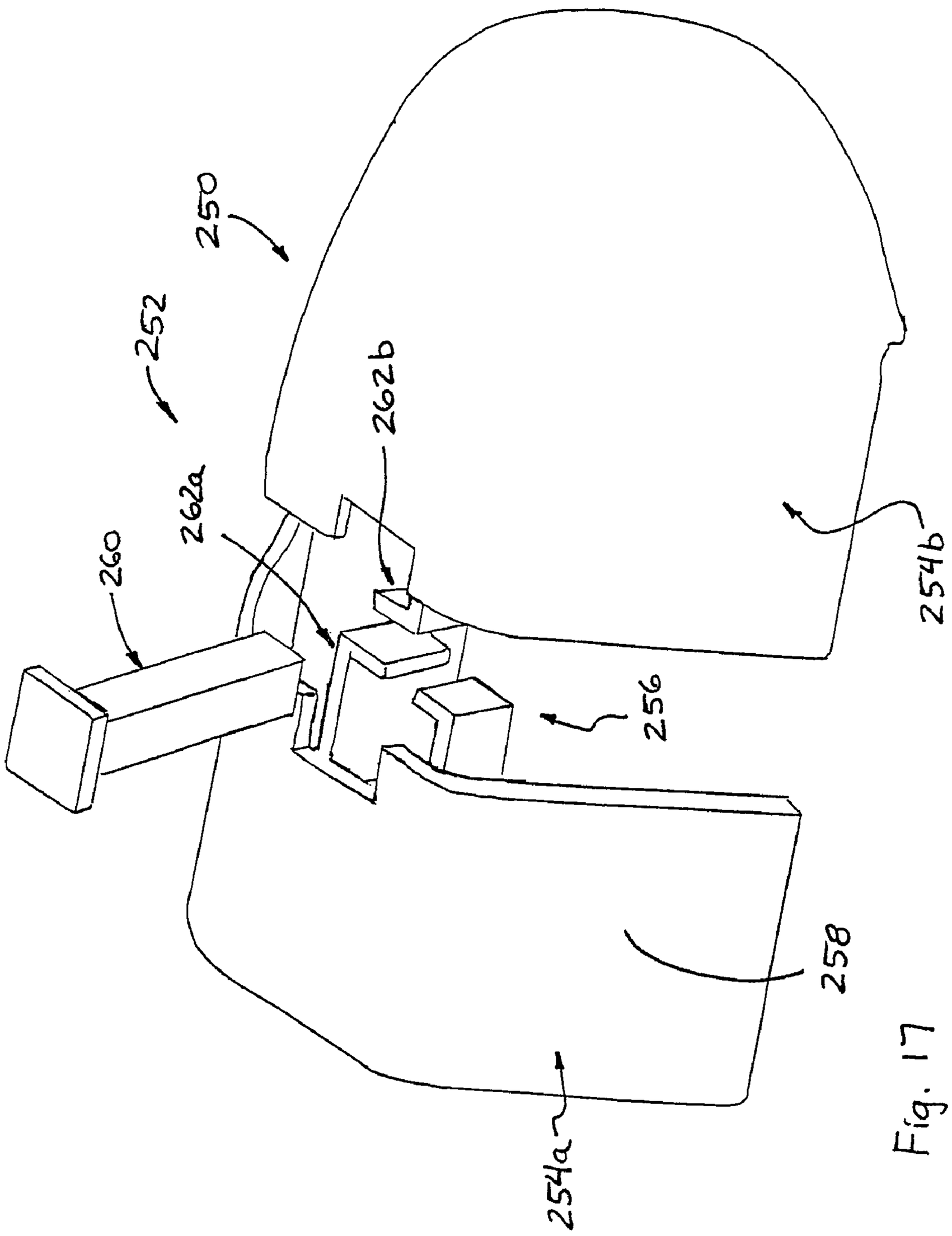

Fig. 17

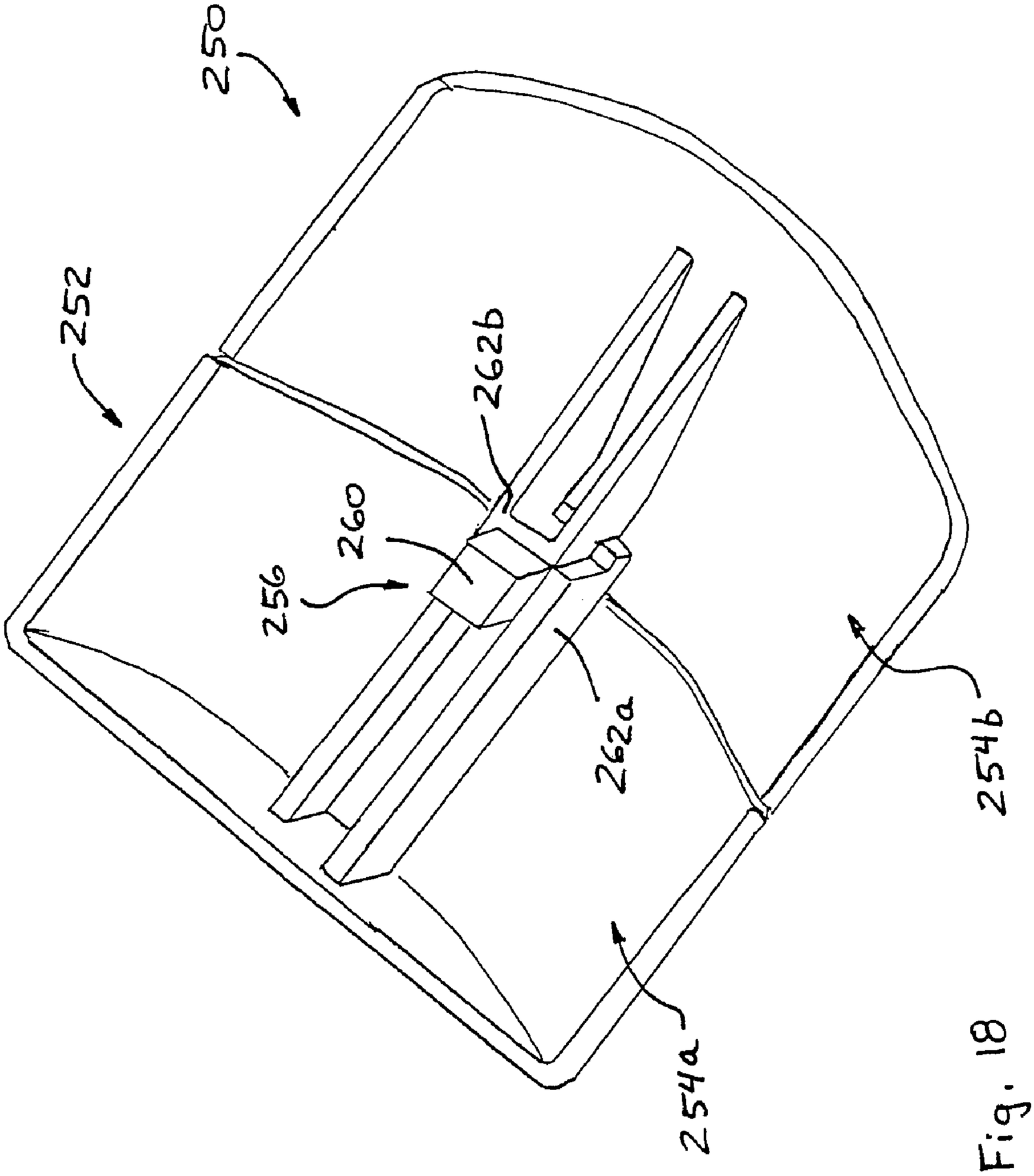

Fig. 18

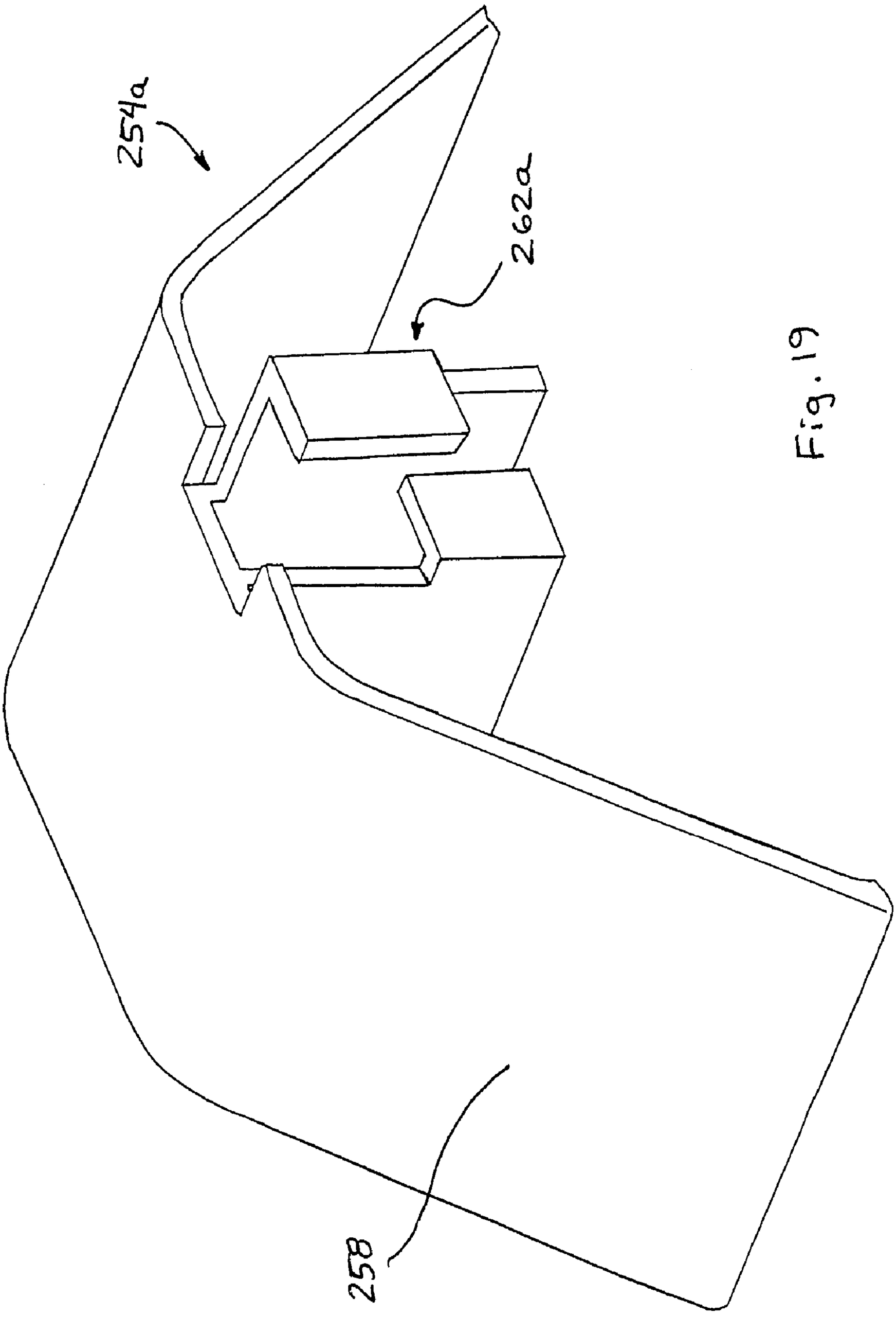

Fig. 19

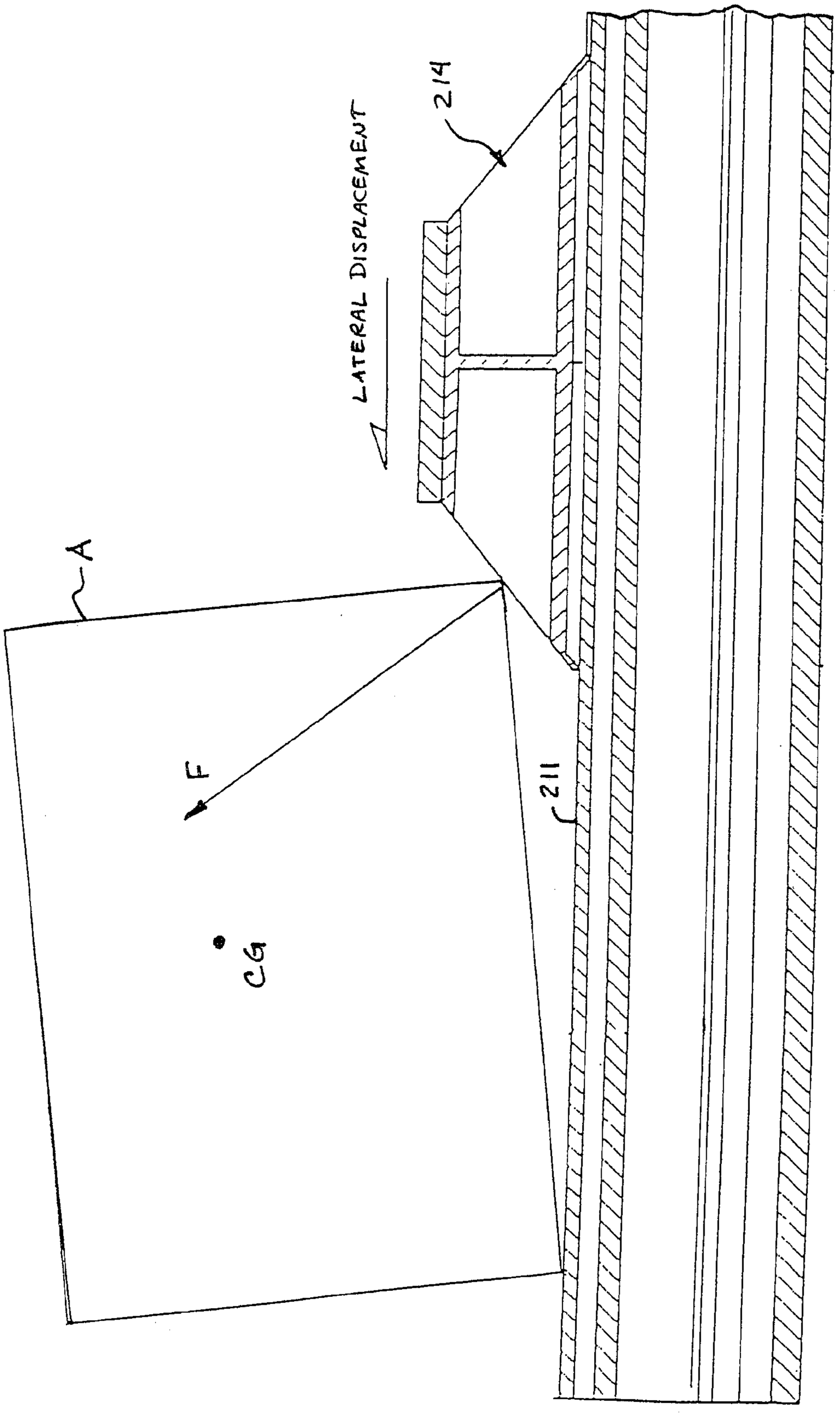

Fig. 20

POSITIVE DISPLACEMENT SORTER SHOE

CROSS REFERENCE TO RELATED APPLICATIONS

The present application is a continuation of U.S. patent application Ser. No. 10/903,707, filed Jul. 30, 2004, now U.S. Pat. No. 7,249,668, which claims benefit of U.S. provisional application, Ser. No. 60/492,144, filed Aug. 1, 2003, which are hereby incorporated herein by reference in their entireties.

FIELD OF THE INVENTION

This invention relates generally to conveyor sortation systems and, more particularly, to a pusher shoe for a positive displacement sorter.

BACKGROUND OF THE INVENTION

Positive displacement sortation conveyors are known having a main conveying surface and diverter shoes, or pusher shoes, that are generally used to displace articles laterally on the main conveying surface, such as when the articles are to be diverted upon one or more spur conveyor lines typically placed at an angle to the main conveying surface. Such conveyors may include a pair of endless chains or other connecting members and a plurality of members, such as slats, connected at their opposite ends to the chains or connecting members in order to provide a moving conveyor surface. Each slat, or a pair of slats, is fitted with a pusher or diverter shoe mounted in a manner such that the shoe moves laterally across the slat or slats. Movement of the shoe is guided by a guide track beneath the conveying surface. At the loading end of the sortation system, the shoes have a particular orientation with respect to the conveying surface. When an article is to be diverted to a particular spur line, a diverter assembly is actuated to switch shoes adjacent the article onto one or more diagonal tracks causing the effected shoes to glide across the slats to divert the article. Examples of such positive displacement sorters include commonly assigned U.S. Pat. Nos. 4,738,347 and 5,127,510. Other examples include U.S. Pat. Nos. 3,361,247; 5,409,095; and 4,884,677; and European Published Pat. Application Nos. EP 0 602 694 B1 and EP 0 444 734 A1.

As such positive displacement sorters increase in speed in order to handle increasing article, or product, throughput, lateral acceleration of the article by the pusher shoe can have detrimental effects. Such effects include, by way of example, tipping of the article, skewing of the article, ballistic separation of the article from the pusher shoe, and the like.

SUMMARY OF THE INVENTION

The present invention is directed to a positive displacement sorter apparatus, and method of sorting that overcomes the detrimental effects created by increased article throughput and the attendant lateral acceleration placed on the articles.

A positive displacement sorter apparatus and method, according to an aspect of the invention, includes providing a plurality of interconnected slats defining an endless web, an upper run of the web defining a conveying surface. A plurality of pusher shoes are provided, each moving along at least one of the plurality of slats to laterally displace articles on the conveying surface. Each of the pusher shoes includes a diverting portion extending above the conveying surface. The diverting portion includes a generally planar diverting surface and a generally planar stop surface extending upward from the diverting surface. The diverting surface contacts an article and laterally displaces that article. A lifting force is applied by the diverting surface to a portion of the article being diverted.

A positive displacement sorter apparatus and method, according to another aspect of the invention, includes providing a plurality of interconnected slats defining an endless web, an upper run of the endless web defining a conveying surface. A plurality of pusher shoes are provided, each moving along at least one of the plurality of slats to laterally displace articles on the conveying surface. Each of the pusher shoes includes a diverting portion extending above the conveying surface. The diverting portion includes a diverting surface. The diverting surface contacts an article and laterally displaces the article. The diverting surface is inclined with respect to the conveying surface from a lower portion adjacent the conveying surface to an upper portion, thereby applying a lifting force to a portion of the article being displaced. A generally vertical surface is provided which extends upwardly from the upper portion of the diverting surface.

A positive displacement sorter apparatus and method, according to another aspect of the invention, includes providing a plurality of interconnected slats defining an endless web, an upper run of the web defining a conveying surface. A plurality of pusher shoes are provided, each moving along at least one of the plurality of slats to laterally displace articles on the conveying surface. Each of the pusher shoes includes a diverting portion extending above the conveying surface. The diverting portion includes a diverting surface. The diverting surface contacts an article and laterally displaces that article. The diverting portion includes a shear joint. The shear joint is adapted to sever upon a force being applied to the pusher shoe that is above a particular level.

According to another aspect of the present invention, a positive displacement sorter apparatus includes a plurality of interconnected slats defining an endless web, with an upper run of the web defining a conveying surface. The apparatus includes a plurality of pusher shoes, with each shoe moving along at least one of the plurality of slats to laterally displace articles on the conveying surface. Each of the pusher shoes includes a diverting portion extending above the conveying surface. The diverting portion includes a lower surface and an upper surface extending upwardly from the lower surface. The lower surface comprises a first or primary or parallel diverting surface and a second or angled or diagonally diverting surface. The first diverting surface is generally normal to the direction of travel of the pusher shoe, and the second diverting surface is angled relative to the first diverting surface. The upper surface comprises a first stop surface and a second stop surface extending upwardly from the first diverting surface and the second diverting surface, respectively. The first diverting surface contacts an article and laterally displaces that article, while the first stop surface limits movement of the pusher shoe relative to the article. The second diverting surface may contact an article and may diagonally divert the article across the conveying surface, while the second stop surface limits movement of the pusher shoe relative to the article.

Therefore, the present invention provides a diverter or pusher shoe that includes a lower diverting surface and an upper stop surface. The diverting surface is angled to absorb the impact of the shoe against an article and to provide a lifting force to the article as the article is pushed or moved across the conveying surface by the pusher shoe. The stop surface limits movement of the shoe relative to the article to limit or substantially preclude the shoe from traveling under the object. The present invention thus provides enhanced control of the article as the article is moved by the pusher

shoes and limits or reduces damage that may otherwise occur to the article upon impact of the pusher shoe against the article.

These and other objects, advantages, purposes and features of the present invention will become apparent upon review of the following specification in conjunction with the drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is perspective view of a positive displacement sorter useful with the present invention;

FIG. **2** is a perspective view of a pusher shoe or diverter shoe in accordance with the present invention;

FIG. **3** is an end elevation of the pusher shoe of FIG. **2**;

FIG. **4** is a perspective view of another pusher shoe of the present invention;

FIG. **5** is a side elevation of the pusher shoe of FIG. **4**;

FIG. **6** is a side elevation of another pusher shoe of the present invention;

FIG. **7** is a side elevation of another pusher shoe of the present invention;

FIG. **8**A is a perspective view of another pusher shoe of the present invention;

FIG. **8**B is a perspective view of another pusher shoe of the present invention;

FIG. **9**A is an end elevation of a multi-faceted pusher shoe in accordance with the present invention;

FIG. **9**B is a top plan view of the pusher shoe of FIG. **9**A;

FIG. **9**C is an end elevation of the pusher shoe of FIGS. **9**A and **9**B;

FIG. **9**D is an end elevation of the other end of the pusher shoe of FIGS. **9**A-C;

FIG. **10** is a perspective view of another pusher shoe of the present invention;

FIG. **11** is a perspective view of another pusher shoe of the present invention;

FIG. **12** is a perspective view of another pusher shoe or diverter shoe and slat combination in accordance with the present invention;

FIG. **13** is a side elevation of the pusher shoe and slat in FIG. **12**;

FIG. **14** is a sectional view taken along the lines XIV-XIV in FIG. **13**;

FIG. **14**A is the same view as FIG. **14** of an alternative embodiment;

FIG. **14**B is the same view as FIG. **14** of an alternative embodiment;

FIG. **15** is the same view as FIG. **12** of an alternative embodiment thereof;

FIG. **16** is a perspective view of an alternative embodiment of a pusher shoe;

FIG. **17** is an exploded perspective view of the pusher shoe of FIG. **16**;

FIG. **18** is an underside perspective view of the pusher shoe of FIGS. **16** and **17**;

FIG. **19** is a perspective view similar to FIG. **17** illustrating a partial diverting portion of the pusher shoe; and

FIG. **20** is the same view as FIG. **14** illustrating lateral displacement of an article.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring now specifically to the drawings, and the illustrative embodiments depicted therein, a sorter assembly apparatus **10** is made up of a plurality of slats **20**, which are interconnected in an endless web **12** with pusher shoes or diverter shoes **14** traveling along some or all of the slats, either on one slat or between two slats, to laterally displace articles A on a conveying surface **11** defined by a top run **13** of endless web **12** (FIG. **1**). Diverter assemblies (not shown) laterally displace pusher shoes **14** to laterally divert articles supported on conveying surface **11** onto selected spurs (not shown) in order to sort the articles. To do this, the diverter assemblies include diverter rails (not shown) extending diagonally across the conveying surface beneath the web to engage transfer assemblies **30** below the conveying surface. Diverter switches (not shown) have actuators to divert the pusher shoe transfer assembly to individual diverter rails.

Sorter assembly **10** may be of the parallel divert type as disclosed in commonly assigned U.S. Pat. No. 5,165,515; of the diagonal divert type as disclosed in commonly assigned U.S. Pat. No. 5,127,510; or a combination of the parallel and diagonal divert type as disclosed in commonly assigned U.S. Pat. Nos. 6,041,909 and 5,927,465, the disclosures of which are all hereby incorporated herein by reference. To the extent not disclosed herein, sorter assembly **10** may be provided according to the principles set forth in commonly assigned U.S. patent application Ser. No. 09/968,742, filed Sep. 28, 2001 by Veit et al. for a POSITIVE DISPLACEMENT SHOE AND SLAT SORTER APPARATUS AND METHOD, now U.S. Pat. No. 6,814,216; Ser. No. 09/840,639, filed Apr. 23, 2001 by Veit et al. for a SORTATION SYSTEM DIVERTER SWITCH, now U.S. Pat. No. 6,615,972; Ser. No. 10/248,981, filed Mar. 3, 2003 by Veit et al. for a POSITIVE DISPLACEMENT SORTER, now U.S. Pat. No. 6,860,383; and Published International Publication Nos. WO 01/83342 A1, published Nov. 8, 2001, and WO 02/26602 A2, published Apr. 4, 2002, the disclosures of which are hereby incorporated herein by reference.

Terms, such as "front" and "rear" and the like, as used herein are relative terms to assist in understanding the disclosed embodiment and should not be considered limiting. References to "upper" and "lower" and the like, as used herein with respect to a slat or a pusher shoe are relative to the slat or the shoe in the upper run of the web. The terms "longitudinal" or "longitudinally" as used herein refer to the direction of movement of the endless web. The terms "lateral" or "laterally" as used herein refer to the direction from side-to-side of the conveying surface, or perpendicular to the direction of movement of the conveying surface.

Pusher shoe **14** includes a diverting portion **16**, which extends above conveying surface **11** (FIGS. **1-5**). The diverting portion includes a diverting surface **18**, which contacts an article A and laterally displaces that article, and a stop surface **22**, which may be a generally vertical surface extending upwardly from the upper end of diverting surface **18**. In the illustrated embodiment of FIGS. **2-5**, diverting surface **18** is a solid surface, but may also be defined by end portions of a series of spaced apart wall segments (such as shown in FIGS. **12-14**B), as would be understood by those skilled in the art. The diverting surface **18** applies a lifting force to a portion of the article being displaced. This is accomplished by diverting surface **18** being at an incline with respect to the conveying surface **11**. The diverting surface may be inclined with respect to the conveying surface at an angle that is less than 90 degrees. This angle may be less than approximately 45 degrees, and may be less than approximately 35 degrees. The diverting surface, in the illustrated embodiment, is at an angle that is approximately 25 degrees with respect to the conveying surface.

While the complete understanding of the manner in which lifting a portion of the article may not be fully understood, it is believed that the sloping surface absorbs acceleration of the

article and tends to rotate the article in the direction of lateral movement of the article. As is illustrated in FIG. **20** (which depicts another embodiment of the diverting shoe of the present invention, discussed below), a force vector F is away from lateral movement of the center of gravity (CG) of the article A. Acceleration of the article A about its center of gravity (CG) is what normally tends to rotate the article clockwise, as illustrated in FIG. **20**. This tends to topple the article being accelerated. By placing the force vector F away from the acceleration of the CG of the article, the rotation or toppling force on the article tends to be offset by a displacement force F in the direction of lateral displacement. It should be understood that this is merely an explanation and is not intended to be limiting.

When an article contacts diverting surface **18**, the contacting portion of the article tends to ride up the diverting surface which is what applies the lifting force to that portion of the article being diverted and absorbs energy. For most articles, it has been found that the article tends to ride partway up the diverting surface to a point where a balance of forces tend to limit further movement between the pusher shoe and the article. However, certain types of packages may continue to ride up diverting surface **18**. In order to avoid the pusher shoe passing beneath such packages, the stop surface **22** may be provided that extends upwardly from an upper portion **24** of diverting surface **18**. An article riding up diverting surface **18** past upper portion **24** engages stop surface **22** which limits or arrests or substantially precludes further movement between the pusher shoe and the article. In the illustrated embodiment of FIGS. **2-5**, stop surface extends substantially upward from the upper end of diverting surface **18** and at a greater angle than the diverting surface. Theoretically, there are no limits to the practical height of stop surface **22**, which may be several inches, or more, in height for handling certain types of packages, such as soft packages.

Optionally, the stop surface **22** may be defined at an upper portion or cap of the pusher shoe **16**. As shown in FIG. **5**, the cap may be formed at the upper end or portion of the diverting surface **18** and may have a shear joint or breakaway joint **28** at the junction of the cap and the upper portion of the diverting surface. The shear joint **28** may be defined by a narrow or thin portion of the pusher shoe **16**, whereby the cap may break off from the pusher shoe if an article exerts excessive force against the stop surface. This functions to limit or substantially preclude damage to the transfer assembly or other parts of the shoe and sorter assembly. Optionally, the shear joint may be positioned elsewhere on the pusher shoe, such as along the lower portion of the diverting surface, such as at the tabs **27** (which may hook or snap onto the pusher assembly), such that the diverting surface may break free from the tabs when an excessive force is applied to the diverting surface and/or the stop surface, in order to limit or substantially preclude damage to the pusher assembly or transfer assembly.

Diverting surface **18** has a lower portion **25** adjacent to conveying surface **11**. In the illustrated embodiment, lower portion **25** includes one or more downwardly extending tabs **27** which ride below conveying surface **11**, namely within shallow slots or grooves or channels **29** defined in and along the upper portion of slat **20**. The presence of the tab or tabs **27** assists the diverting surface **18** in extending or getting under the article in order to avoid occasionally diverting the article as a result of contact with lower portion **25**.

As shown in FIGS. **2-5**, stop surface **22** may extend upwardly from diverting surface **18** and may be at an angle relative to the conveying surface that is greater than that of diverting surface **18**. In the illustrated embodiment, the diverting surface is at an angle of approximately 25 degrees, while stop surface is at an angle of approximately 75 degrees. Clearly, other angles of the two surfaces may be implemented without affecting the scope of the present invention. For example, and with reference to FIG. **6**, a stop surface **22'** may be at about a 90 degree angle and thus may extend generally vertically upward from the upper portion **24** of diverting surface **18**. Optionally, for example, and with reference to FIG. **7**, the stop surfaces **22"** at the upper portion **24** of the diverting surface **18** may be angled less than approximately 75 degrees, such as about 45 degrees, to further limit movement of the article up the diverting surface of the diverting shoe. As shown in FIG. **7**, the stop surfaces **22"** may intersect at the upper end **22***a***"** of the diverter shoe.

As shown in FIGS. **2-7**, the diverter or pusher shoes may include a diverting surface and a stop surface at both ends of the shoe so that the shoe may be utilized to move articles in either direction across a conveying surface. However, it is envisioned that the pusher shoe may be formed as a unidirectional shoe with a diverting surface and a stop surface at one end, but not at the other end, without affecting the scope of the present invention. Optionally, for example, and as discussed below with respect to FIGS. **14**A and **14**B, a pusher shoe may include a diverting surface and a generally vertical stop surface at one end and a diverting surface and ramped surface or upper diverting surface at the other end, without affecting the scope of the present invention.

Optionally, the pusher shoe may have one or both ends or sides angled or inclined to allow an article to ride up and over the shoe in situations where an article is engaged by the shoe when the shoe is moving back toward its initial position. For example, after a shoe or set of shoes has diverted an article across the conveying surface, the shoe or set of shoes is returned to its initial side of the conveying surface to prepare to receive or engage another article. While the shoe is moving back to the initial side, the shoe may contact an article that is being pushed or diverted across the conveying surface by an adjacent shoe or set of shoes. When such contact occurs, it is desirable that the article slide up and over the returning shoe so that the pushing shoe can continue to push or divert the article across the conveying surface.

As shown in FIG. **8**A, a pusher shoe **14'"** may include a diverting portion **16'"** that has sloped or inclined end surfaces **32**, which may be at the ends or sides of the stop surfaces **22'"** and generally above the diverting surfaces **18'"**. Similarly, and as shown in FIG. **8**B, a pusher shoe **14""** may include a diverting portion **16""** having a sloped or inclined end surface **32'** at each end, and may include angled surfaces **34***a*, **34***b* at opposite sides of each end surface **32'** and between the end surface **32'** and the respective stop surface **22""** at the upper portion of the diverting surface **18""**. The angled surfaces **34***a*, **34***b* allow an article that is contacted by the returning shoe to ride up and over the shoe without jamming or hanging up on the shoe as the article is moved in one direction (by another shoe or set of shoes) and contacts or encounters the shoe **14""** that is being moved in the other direction.

Referring now to FIGS. **9**A-D, a pusher shoe, **114** may comprise a multi-faceted shoe having a diverting portion **116**, which extends above the conveying surface as described above. The diverting portion **116** includes a multi-faceted diverting surface having diverting surfaces **118***a*, **118***b* and a multi-faceted stop surface having stop surfaces **122***a*, **122***b*. As can be seen with reference to FIGS. **9**C and **9**D, stop surfaces **122***a*, **122***b* may be oriented generally vertically at the upper portions of diverting surfaces **118***a*, **118***b*, but may be otherwise angled at a greater angle relative to the conveying surface than that of the diverting surfaces, without affecting the scope of the present invention. The diverting surfaces

118*a*, **118***b* are generally planar surfaces and oriented at an angle such that one surface **118***a* comprises a parallel diverting surface or primary or initial diverting surface and is generally normal to the longitudinal direction of the slat, while the other surface **118***b* is at an angle toward one side of the slat, and thus may comprise a diagonal diverting surface or secondary diverting surface. The angled or diagonal diverting surface **118***b* allows the pusher shoes to angle an article or move the article diagonally across the conveying surface while maintaining substantially uniform contact between the article and the pusher shoe. The first or initial surface **118***a* may initially contact the article whereby the article may then rotate or pivot into alignment with the secondary or angled diverting surface to move the article at an angle across the conveying surface.

The multi-faceted diverting surface **118** thus may provide a first or main or primary or parallel diverting surface **118***a* that at least initially engages the article. As disclosed in commonly assigned U.S. Pat. Nos. 6,041,909 and 6,513,642 issued to Shearer et al., the disclosures of which are hereby incorporated herein by reference, the sorter assembly may divert articles of certain length using parallel diverting, and may divert articles of different lengths using diagonal diverting. When used for parallel diverting, primary diverting surface **118***a* pushes and moves an article across the conveying surface. Alternately, when used for diagonal diverting, the angled or secondary diverting surface **118***b* may be arranged at an angle relative to the primary or initial diverting surface **118***a* and may function to push and move an article diagonally across the conveying surface. The primary or initial diverting surface **118***a* may initially contact the article to cause the article to rotate or pivot into alignment with the secondary or angled diverting surface **118***b* as the pusher shoes are moved across the conveying surface. The end surface or surfaces may be inclined to assist in allowing an article to ride over the pusher shoe when the shoe contacts an article when returning to the initial position, such as described above with respect to angled end surfaces **32**, **32'**.

Optionally, and as shown in FIG. **10**, a multi-faceted pusher shoe **114'** may include a diverter portion **116'** having a primary or initial diverting surface **118***a'* and an angled or secondary or diagonal diverting surface **118***b'*, with a generally vertical stop surface **122'** extending generally upward from the secondary diverting surface **118***b'*. The primary or initial diverting surface **118***a'* may extend from the lower portion of the shoe (and generally at the conveying surface) to the upper portion of the shoe (and generally at the upper end or portion of the stop surface **122'**). The end surface **132** may be angled or inclined to allow an article to ride over the pusher shoe when the shoe contacts an article when returning to the initial position, such as described above with respect to angled end surfaces **32**, **32'**. The stop surface **122'** may also include an angled or inclined surface **122***a'* at an end thereof to limit jamming of articles at the pusher shoe. Optionally, and as shown in FIG. **11**, a pusher shoe **114"** may include a diverting portion **116"** that has a primary or initial diverting surface **118***a"* and an angled or secondary or diagonal diverting surface **118***b"*, with an inclined end surface **132'**.

Referring now to FIGS. **12-14**B and **20**, a pusher shoe **214** includes a diverting portion **216**, which extends above a conveying surface **211**. The diverting portion includes a diverting surface **218** which contacts an article and laterally displaces that article. In the illustrated embodiments of FIGS. **12-14**B, diverting surface **218** is defined by end portions of a series of spaced apart wall segments **219**, but may also be a solid surface as would be understood by those skilled in the art. The diverting surface **218** applies a lifting force to a portion of the article being displaced. In the embodiments illustrated in FIGS. **12-14**B, this is accomplished by diverting surface **218** being at an incline with respect to the conveying surface **211**. The diverting surface may be inclined with respect to the conveying surface at an angle that is less than 90 degrees. This angle may be less than approximately 45 degrees, and may be less than approximately 35 degrees. The diverting surface, in the illustrated embodiment, is at an angle that is approximately 25 degrees with respect to the conveying surface.

When an article contacts diverting surface **218**, the contacting portion of the article tends to ride up the diverting surface which is what applies the lifting force to that portion of the article being diverted and absorbs energy. For most articles, it has been found that the article tends to ride partway up the diverting surface to a point where a balance of forces tend to limit further movement between the pusher shoe and the article. However, certain types of packages may continue to ride up diverting surface **218**. In order to avoid the pusher shoe passing beneath such packages, a generally vertical stop surface **222** may be provided that extends upwardly from an upper portion **224** of diverting surface **218**. An article riding up diverting surface **218** past upper portion **224** engages generally vertical surface **222** which arrests further movement between the pusher shoe and the article. Generally vertical surface **222** may extend at least approximately 0.25 inches above upper portion **224**. Theoretically, there are no limits to the practical height of generally vertical surface **222**, which may be several inches, or more, in height for handling certain types of packages, such as soft packages. Diverting portion **218** has a lower portion **225** adjacent conveying surface **211**. In the illustrated embodiment, lower portion **225** includes one or more downwardly extending tabs **227** which ride below conveying surface **211**, namely within shallow slots **229** (FIG. **12**) defined in the upper portion of slat **220**. The presence of the tab or tabs **227** assists the diverting surface **218** in extending or getting under the article in order to avoid occasionally diverting the article as a result of contact with lower portion **225**.

Optionally, generally vertical surface **222** may be defined by a cap **226** which is fastened to diverting portion **216**. Alternatively, generally vertical surface **222** may be integrally formed with diverting portion **216**. Optionally, cap **226** may be connected with diverting portion **216**, such as by a shear joint **228**. Shear joint **228** is configured to break loose upon a placement of a relative force between cap **226** and diverting portion **216** that exceeds a particular level. Shear joint **228** provides protection to the sorter apparatus as follows. Should an article become jammed against a fixed obstacle, or a logjam of packages, or the like, the article will ride up diverting surface **218** and will be engaged by generally vertical stop surface **222**. Because, under this scenario, the object will be incapable of free movement, a force will be applied to cap **226** that exceeds the shearing force of shear joint **228**. This will cause the shear joint to break loose and the cap **226** to separate from the remaining portion of the diverting portion **216**. The presence of a shear joint increases the likelihood that any damage to pusher shoe **214** caused by a jammed condition, or the like, will occur at diverting portion **216** which is easily accessible to a service technician. This tends to reduce failure at transfer element **230** which is below the conveying surface and would require at least partial disassembly of the conveying surface in order to make repair thereon. Therefore, the presence of a shear joint facilitates a reduction in maintenance cost in downtime to the sorter apparatus caused by a jam.

Cap **226** may include leading and trailing surfaces **232** which are extensions of leading and trailing surfaces **234**

defined by diverting portions **216**. This assists movement of the pusher shoe under a package that is engaged by the leading or trailing surfaces of pusher shoe **214**, as will be understood by the skilled artisan. As can best be seen by reference to FIGS. **14**, **14**A and **14**B, pusher shoe **214** may be easily adapted to a left-hand divert, a right-hand divert, or a bi-lateral divert. In the embodiment illustrated in FIG. **14**, a bi-lateral divert is provided by the presence of an additional generally vertical surface **222** at opposite lateral sides of cap **226**. In the embodiment illustrated in FIG. **14**A, in order to make a left-hand divert as viewed in FIG. **14**A, cap **226***a* includes a generally vertical surface **222***a* and a sloping surface **236***a* which extends from generally vertical surface **222***a* to the other diverting surface **218'**. In order to make a right-hand divert, as viewed in FIG. **14**B, a generally vertical surface **222***b* is positioned on an opposite lateral side of a cap **226***b*, as illustrated in FIG. **14**B, and which slopes down to a sloping surface **236***b* to a diverting surface **218**. Thus, it is seen that only two, or perhaps three, configurations of a cap may be implemented in order to convert the sorter apparatus between a bi-lateral divert, a left-hand divert, or a right-hand divert. The remaining portions of the pusher shoes may be substantially identical. In the case of a left-hand or right-hand divert, respective sloping surfaces **236***a*, **236***b* tend to pass beneath a jammed package and thereby provide anti-jam protection.

In an alternative, less preferred, embodiment, illustrated in FIG. **15**, a diverting surface **240** of a diverting portion **216'** is defined by a contact surface portion **242** and a lifting surface portion surface **244**. Diverting surface **240** applies a lifting force to a portion of the article being laterally displaced in a manner described below. An article being diverted passes over lifting surface portions **244** which are located within slots **229** below conveying surface **211**. After the article passes over the lifting surface portions **244**, the article engages contact surface portion **242**. Diverting surface **240** is pivoted with respect to diverting portion **216'**, such as by a pivot joint **246**. When the article engages contact surface portion **242**, the diverting surface **244** pivots about pivot joint **246**, thereby causing lifting surface portion **244** to pivot upwardly as illustrated by the arrows in FIG. **15**. This places a lifting force to a portion of the article being displaced. Other examples of techniques utilized for applying a lifting force to a portion of the article being displaced will suggest themselves to the skilled artisan and are intended to be embraced by the invention.

In an alternative embodiment, and with reference to FIGS. **16-19**, a pusher shoe **250** includes a diverting portion **252** having at least first and second members **254***a*, **254***b* which are joined by a shear joint **256**. Member **254***a* may have a diverting surface **258**, which may be a conventional generally vertical diverting surface, and sloping surface **259** which slopes downwardly from an upper extent of members **254***a*, **254***b* to the conveying surface (not shown in FIGS. **16-19**). As illustrated, shear joint **256** may include a shear pin **260** which engages joining portions **262***a* of member **254***a* and **262***b* of member **254***b*. When pusher shoe **250** engages a fixed article which is jammed against a stationary object, and provided that sloping surface **259** does not pass beneath the article, shear pin **260** should either disengage from joint portions **262***a*, **262***b* or may otherwise break loose into separate members in order to allow diverting members **254***a*, **254***b* to separate, thereby causing the force implied on the pusher shoe to be absorbed by the diverting portion, not the transfer assembly. Thus, it is seen that at least an aspect of the present invention can be applied to more conventional pusher shoes having generally vertical diverting surfaces. It should be understood that the shear joints **228**, **256** discussed herein are not limited to those depicted in the illustrated embodiments but may be implemented by other designs of shear joints that would suggest themselves to the skilled artisan.

Therefore, the present invention provides a diverter shoe that has a diverting surface and a stop surface. The diverting surface engages and pushes or moves an object or article while absorbing the impact at the article by allowing the article to move upward along the sloped diverting surface. The stop surface is at a greater angle than the diverting surface and functions to engage the article if the article moves upward to the upper end of the diverting surface, in order to substantially preclude the diverter shoe from sliding under the article. The diverting surface and stop surface may be at various angles, with the stop surface preferably being at a greater angle relative to the conveying surface than that of the diverting surface, and preferably being substantially vertical or normal to the conveying surface. The diverter shoe may include an angled or deflecting surface for directing or angling an article relative to the diverting surface to move the article diagonally across the conveying surface or to deflect articles out of the way of the diverter shoe if the article is not aligned with the diverter shoe.

Changes and modifications in the specifically described embodiments can be carried out without departing from the principles of the present invention which is intended to be limited only by the scope of the appended claims, as interpreted according to the principles of patent law including the doctrine of equivalents.

The embodiments of the invention in which an exclusive property or privilege is claimed are defined as follows:

1. A positive displacement sorter apparatus comprising:

a plurality of interconnected slats defining an endless web, an upper run of said web defining a conveying surface;

a plurality of pusher shoes, each of said plurality of pusher shoes moving along at least one of said plurality of slats to laterally displace articles on said conveying surface; and wherein each of said pusher shoes comprises a diverting portion and a shear element, said diverting portion extending upward from said conveying surface for contacting an article and laterally displacing that article as said pusher shoe is moved along said at least one of said plurality of slats, said shear element being established at said diverting portion and adapted to fail upon a force being applied to at least a portion of said diverting portion that is above a particular level wherein said shear element is disposed above said conveying surface.

2. The sorter apparatus of claim **1**, wherein each of said pusher shoes includes a base portion configured to mount said pusher shoe to said at least one of said plurality of slats.

3. The sorter apparatus of claim **2**, wherein said shear element severs to separate said diverting portion from said base portion.

4. The sorter apparatus of claim **1**, wherein said shear element is located at a lower portion of said diverting portion at or near said conveying surface.

5. The sorter apparatus of claim **1**, wherein said shear element includes a shear pin.

6. The sorter apparatus of claim **1**, wherein said diverting portion comprises an inclined diverting surface and a stop surface extending upward from an upper portion of said diverting surface.

7. The sorter apparatus of claim **6**, wherein said shear element is located at a junction between said stop surface and said upper portion of said inclined diverting surface.

8. The sorter apparatus of claim 7, wherein said diverting surface comprises an inclined diverting surface and said stop surface defines a generally vertical stop surface, said shear element being adapted to sever in response to a force being applied to said stop surface that exceeds a particular level.

9. The sorter apparatus of claim 5, wherein said diverting portion and said shear pin are configured such that said shear pin disengages from said diverting portion in response to a force being applied to at least a portion of said diverting portion that exceeds a particular level.

10. The sorter apparatus of claim 1, wherein said shear element fails in order to separate said diverting portion from another portion of said pusher shoe.

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